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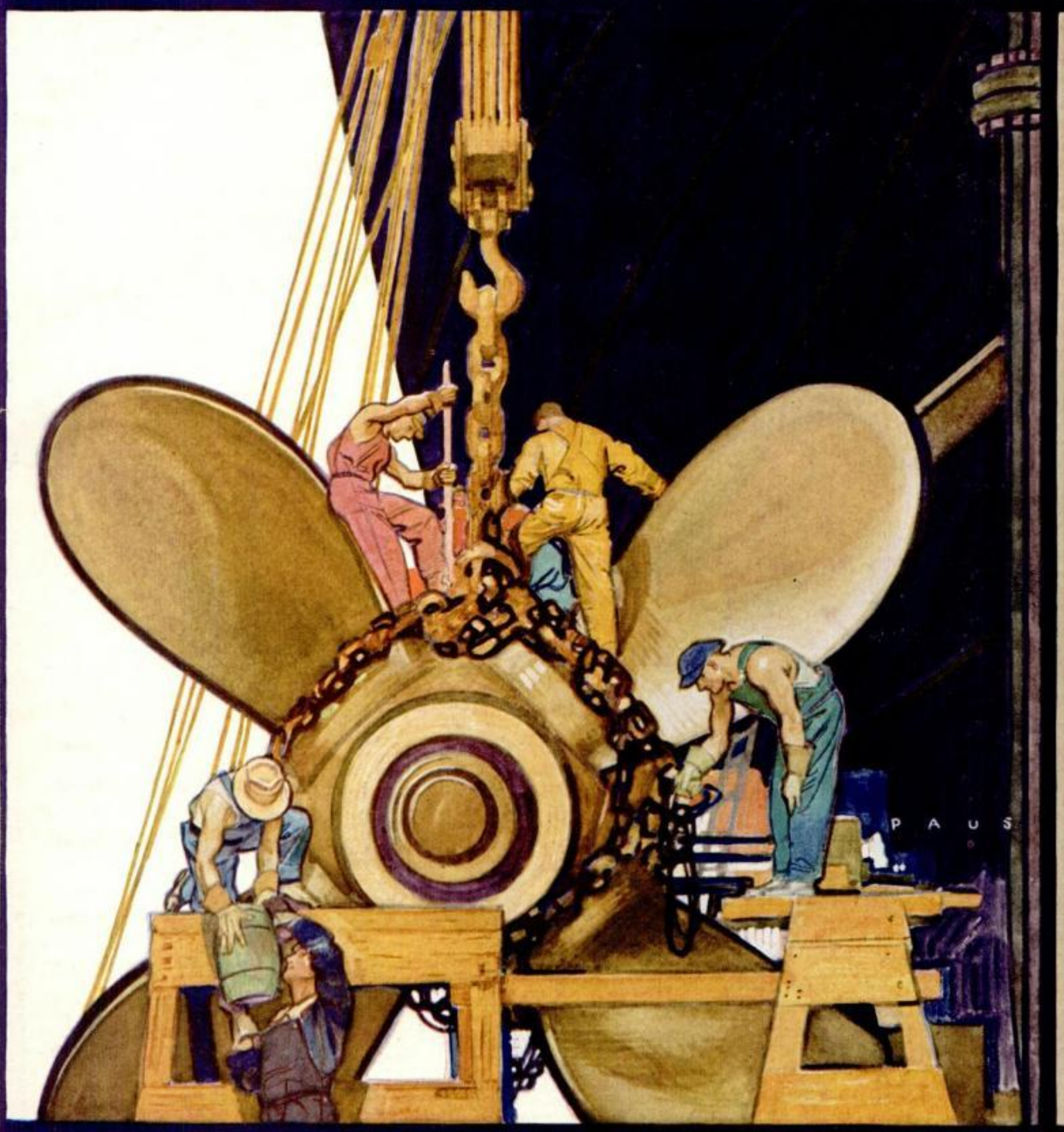

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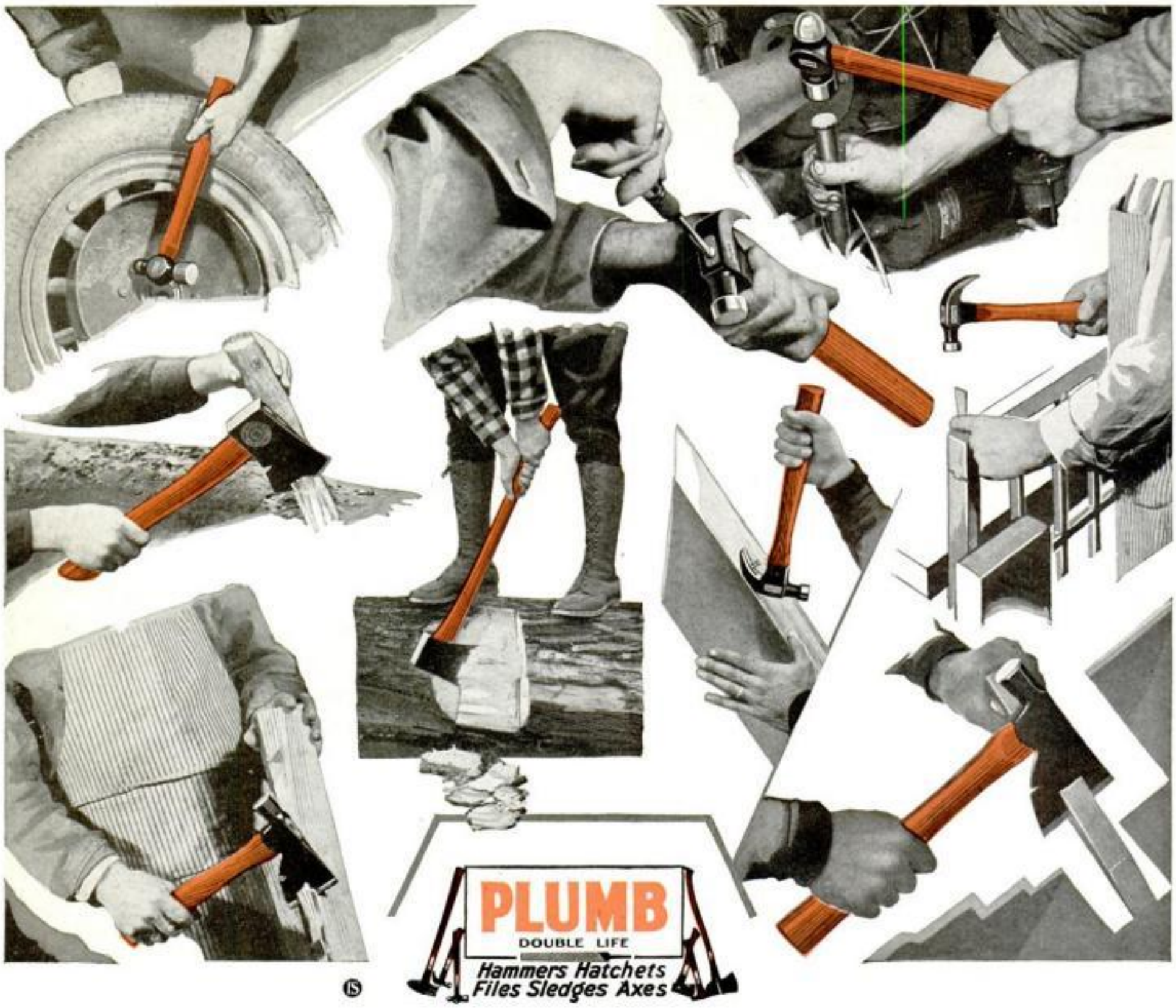

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Popular Science Monthly for January, 1930

"DIVIDENDS PAYABLE IN STOCK"

—*What does it mean?*

By WALLACE AMES, *Financial Editor*

The Gleason family were holding their regular January 1 round-table conference to try to find out what had happened to their money and their plans for getting ahead in the world during the past year. Also, to lay financial plans for the new year. Mr. Gleason held in his hand the neatly typed budget and schedule which had been prepared just twelve months ago. He frowned as he looked at it.

"Let's see," he said, putting his forefinger on the last line of the document. "It says here that we ought to have put by and invested $2,200 last year, over and above all expenses. Did we do it?"

Dead silence.

"No!" exclaimed the head of the family, scowling toward Mrs. Gleason and his daughter Minnie. "The answer is no. Nor half of it."

"It was a hard year," murmured Mrs. Gleason soothingly. "Donald's sickness and the doctor's bills . . . "

"Allowed for in the budget," exclaimed Mr. Gleason, thumping his finger on the item on the typewritten page. "No, no, my dear," he went on, seeing the distressed look on Mrs. Gleason's face, "it wasn't any one item of expense, or extravagant living, or carelessness, that put us back. Year after year we have gone through this, making good resolutions, drawing up elaborate plans, and always falling far short of what we vowed we would save. There's something wrong with our system."

"I'll tell you what is wrong," cried Minnie, who for the last month had been proudly holding down the job of private secretary to Samuel J. Sturgess, vice-president of the biggest department store in town. "You don't make any allowance for ap-pre-ci-a-tion."

"Appreciation?" Mr. Gleason stared at her. "You mean I don't appreciate a good investment?"

"Well, maybe I mean that," Minnie admitted vaguely, "but I don't think so. The way Mr. Sturgess uses the word it seems to mean an increase in the value of the investments you own. Either the price goes up or the company you invest in gives you more stock without charging you for it, so that you own more at the end of the year than you did at the beginning."

"Without paying for it?" her father demanded incredulously.

"Yes. I don't know much about it—only this: Mr. Sturgess got a registered letter the other day from a company he owns stock in. There was a certificate for ten new shares of stock enclosed, and with it a printed slip saying that they were sending his regular 'stock dividend.' While he was looking at the certificate Mr. Austin, the auditor, came in. He said, 'Looks as though you were making money, Sam.' And Mr. Sturgess said, 'Well, this stock has appreciated quite a bit. I am keeping my dividends instead of selling them, so it mounts up faster.'"

Mr. Gleason pondered for a while. Then he walked to the door and called up-stairs, "Archie, come down here for a minute, will you?"

Archibald Gleason worked in the stock transfer department of a down-town trust company. He was an ambitious young fellow and spent a good part of his evenings studying a course in investments and finance. "What is it, Father?" he asked as he came into the room.

"What's all this about stock dividends that you get without paying for?" Mr. Gleason demanded.

Archie laughed. "Well, that's it. You get stock without paying for it."

Mr. Gleason looked bewildered, so his son went on, "It's like this. Say you own stock in a company that is making money. It could pay you cash dividends easily enough. But instead of that it pays dividends in stock.

"Take a case like this. You own 100 shares in a certain company worth say $30 a share. You have been getting 30 cents a share every three months in cash, $1.20 a year. Your total dividends are $120 a year. Then one day the company sends you a notice that hereafter you can take your choice between 30 cents quarterly in cash, or 2 per cent quarterly in stock—that is, two new shares of stock each three months, or eight new shares per year."

"Why would they do that?" Mr. Gleason demanded.

"They might do it for several reasons. A growing, successful company sometimes feels that it can make good use of all the money it earns in order to make more money. It sees the opportunity to use more capital. Now, if it paid out cash dividends it might soon come to the point where it would be necessary for it to sell more stock to increase its capital. In that case it would first offer the new stock to its old stockholders, and those stockholders might actually use the cash dividends they had been getting in order to buy the new shares. Why not shorten and simplify the process and save expense by giving them the stock in the first place, while the company keeps the cash?"

(*Continued on page 5*)

"Dividends Payable in Stock"

(Continued from page 4)

"Sounds reasonable," Mr. Gleason agreed.

"Besides that," Archie went on, "a company naturally likes to keep its stockholders sold, wants them to have a growing interest in the company. It cost money to get those stockholders in the first place, so it is natural to raise additional money from them, instead of selling to outsiders who don't know nearly as much about the company's affairs."

Again Mr. Gleason nodded.

"Now," said Archie, "let's go back for a minute to the company I was using as an illustration. Thirty cents quarterly in cash, or 2 per cent in stock, worth $30 a share. On 100 shares your quarterly cash dividend would be $30. On the same number of shares you would get 2 shares of new stock worth $60 in the market."

Mr. Gleason sat up straight at this indication of a profitable deal. "Yes," he exclaimed, "that looks all right. But suppose when you have taken your dividend in stock you find you need the money. What then?"

"Sell your dividend stock," Archie explained. "You can get the market price, less the usual small brokers' commission."

"Is this plan of giving stock dividends sound?" Mr. Gleason inquired doubtfully. "Some years ago there was a lot of talk about 'watered stock,' meaning that stock was issued without any real value behind it. When a company keeps on putting out more shares isn't it watering its stock?"

"It all depends on the company and its earnings. If a company is standing still, not adding anything to its assets and not increasing its earnings, of course the new stock is just 'water.' But where earnings are increasing it is just as proper for a company to capitalize them as to pay them out as cash dividends."

"Capitalize? Just what do you mean by that?"

"I mean to regard current earnings as capital instead of just income—capital that is put back to work in the business. When money is turned back into the business this way new stock may be issued representing that capital. When a company sells stock for cash it raises capital which is represented by the stock. It's just the same thing when, instead of selling new stock for cash, it provides the cash itself by keeping and reinvesting its earnings and issues new stock against it."

Mr. Gleason rubbed his chin thoughtfully. "It seems to me," he said at last, "that if you invest in the right kind of a company that pays stock dividends it will help you to accumulate money. It works something like compound interest, doesn't it?"

"Yes, in a way," Archie said. "Take that imaginary case I spoke of—an investment in 100 shares of stock on which 8% stock dividends are paid each year. The first year you get 8 shares of dividend stock. Next year you get another 8 shares on the original

(Continued on page 6

"Dividends Payable in Stock"

(Continued from page 5)

100, plus a fractional certificate for .64 of a share, representing the 8% dividend on the 8 new shares you got last year. And so on, with the dividends constantly getting larger."

"Now, look here," exclaimed Mr. Gleason suddenly, "suppose, besides getting your stock dividends, the price of the stock goes up each year—you ought to make money that much faster!"

"Of course you would," Archie replied calmly. "Each year you own more stock and each year it is worth more money. But you want to remember that you can't pick up an investment like that with your eyes shut. In other words, there isn't any magic about stock dividends that will make a man rich. They are merely a way of reinvesting money in the company, and that is one of the hardest things anybody has to learn—how to reinvest regularly. Yet that is the real secret of getting ahead—that and choosing good investments in the first place."

"It might be a good rule," Mr. Gleason ventured, "not to invest in any company that pays stock dividends unless you would be willing to invest in it if it did not."

"Sure," said Archie. "Look up its earnings and its record, just as you do now when you invest. That's the only test."

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

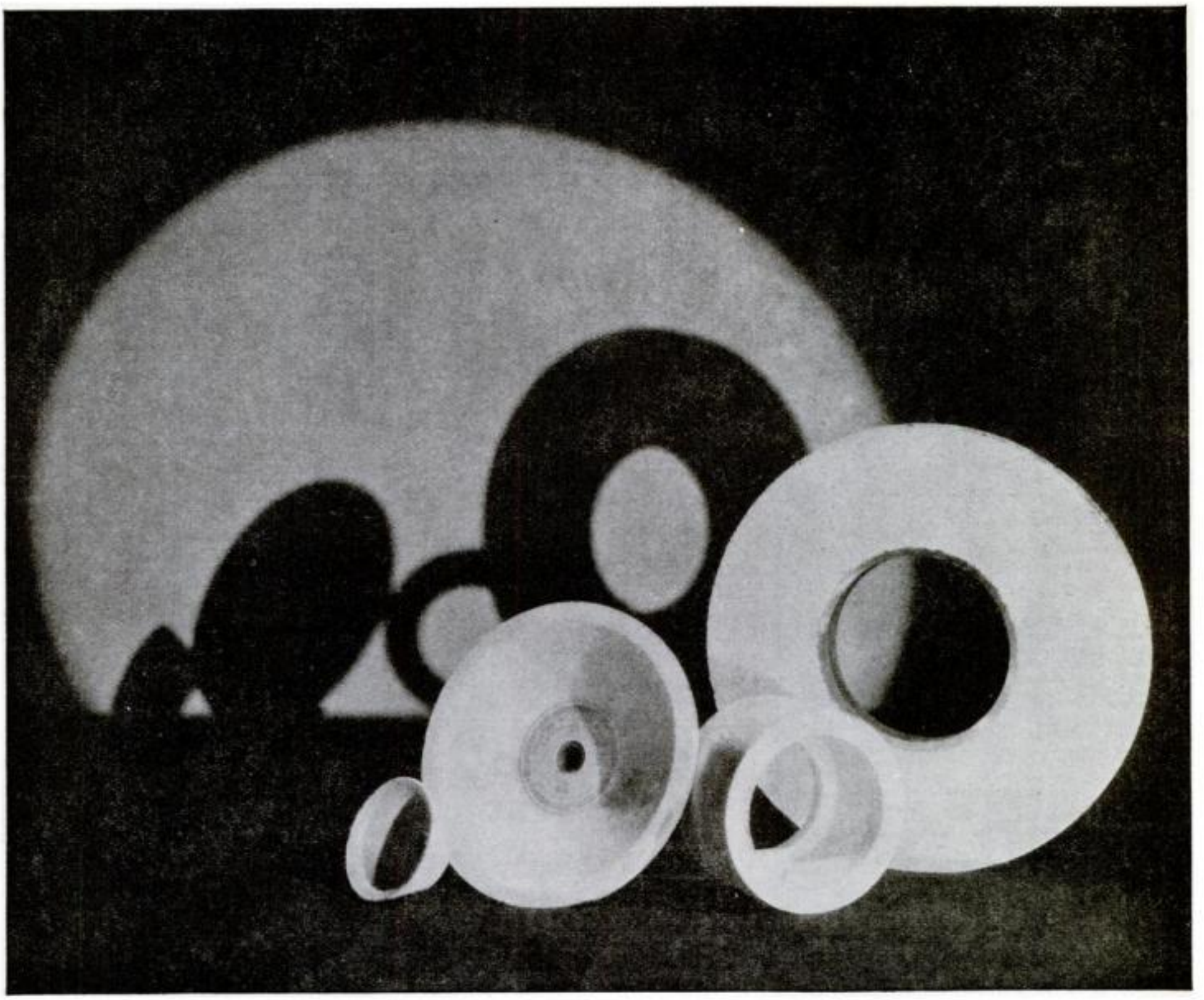
The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

Prize Investment List Comparisons: This folder compares the record of Financial Investing Co., of New York, Ltd., with the results achieved during the past four years by 14 prize-winning investment recommendations. It shows how Financial Investing shares gained 59% in value and returned an average of 13.35% to investors. For a copy write The Fiscal Securities Corporation, Room 2808, 48 Wall Street, New York.



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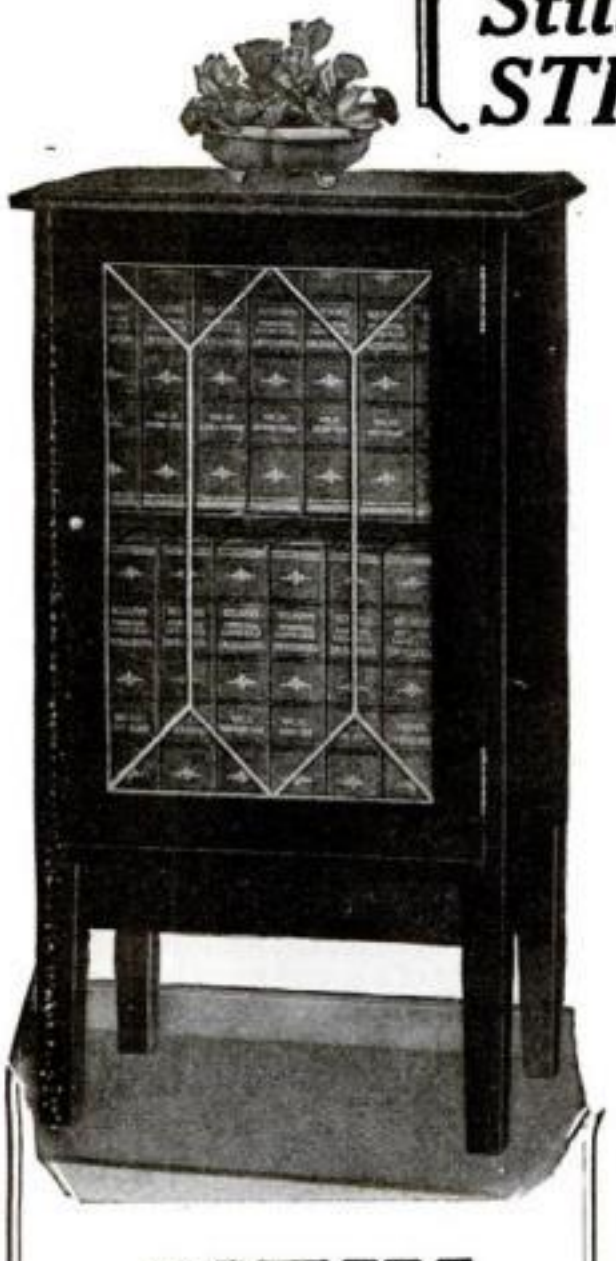

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Pop.Sc.M. 1-30

Why the New Sets Are Better

An Exact Comparison between 1929 and 1930 Receivers Is Given by Test Measurements in Institute Laboratory

A group of the 1930 receiving sets undergoing test in the Popular Science Institute laboratory at New York University. The tests gave an accurate picture of just how the new sets will perform.

By COLLINS P. BLISS
Director, Popular Science Institute

A VERY interesting comparison between the radio receivers produced last year and the new models now being sold is provided by checking Popular Science Institute's test records against each other.

Aside from appearance which, of course, is a matter of individual preference, a radio receiver is good in proportion to its ability to bring in stations, to choose between stations, and to faithfully reproduce the music or speech with plenty of volume.

The standard method of determining the ability of a radio receiver to bring in different stations is measured in The Institute's laboratory in microvolts per meter. Briefly, this method consists in determining how small, or rather how weak, a signal will produce a standard loudspeaker signal from the set. Obviously the receiver which will produce the standard loudspeaker signals from the weakest input signals is the most sensitive. The table below gives the average sensitivity of a large group of 1929 receivers as compared with a large group of 1930 models at three different frequencies representing the upper, middle, and lower end of the broadcast band:

Frequency	*1929 Models*	*1930 Models*
	Microvolts per M	
600 Kc.	35	14.5
1000 Kc.	12.5	10.0
1400 Kc.	10.5	7.7

An examination of these figures reveals some very interesting facts. On the middle of the broadcast band, the 1930 sets are only slightly more sensitive than last year's models, and this applies also on the frequencies that are received at the lower end of the dials. Near the upper end of the dial, however, the sets this year average more than twice as sensitive as last year's sets, and what is still more important, the latest receivers are much more uniformly sensitive throughout the broadcast band.

The selectivity of a radio receiver, which means its ability to choose between different stations that are relatively close together on the dial, is determined by finding how far the dial must be shifted from a station of given intensity in order to reduce the signal to a given amount. In the table below, therefore, the lower the figure, the more selective the receiver. The test conditions are made severe and correspond roughly to attempting to tune a weak distant station through a powerful local station.

Test at	*1929 Models*	*1930 Models*
600 Kc.	26 Kc.	17 Kc.
1000 Kc.	47 Kc.	34 Kc.
1400 Kc.	115 Kc.	94 Kc.

AN EXAMINATION of these figures shows quite conclusively that the latest types of radio receivers are, on the average, considerably more selective than last year's models.

The ideal radio receiver would reproduce all tone frequencies in exactly the same manner. While many of the modern sets approach within striking distance of the ideal as far as the human ear is concerned, they are not perfect and it is therefore possible to make definite measurements of the error. The table below shows how near the receivers approach perfection at three points in frequency band. Note the great improvement in 1930 models.

	1929 Models	*1930 Models*
90-cycle response.....	54%	64%
3000-cycle response at 600 Kc.....	28%	38%
3000-cycle response at 1200 Kc.....	41%	62%

In studying these figures it is well to bear in mind the limitations of the human ear. It has been found, for instance, that the intensity of a sound must be varied at least 50% before a change becomes perceptible to the human ear. Thus, for instance, where 64% is given for the 90-cycle response, a change to a full 100% would be just bareiy perceptible to the ear. That shows how closely the modern radio receiver approaches to absolute perfection.

A radio investment made at this time can be considered a lasting one, for a high enough degree of perfection has been attained so that further improvement will come very slowly.

* * *

READERS who are planning to invest in one of the new sets may obtain free a list of the radio receivers that The Institute has found to be good value according to 1930 standards. Requests for this list and inquiries regarding special radio buying problems should be addressed to Popular Science Institute, 381 Fourth Ave., New York, N. Y.

INSTITUTE BULLETINS

- List of Approved Radio Products
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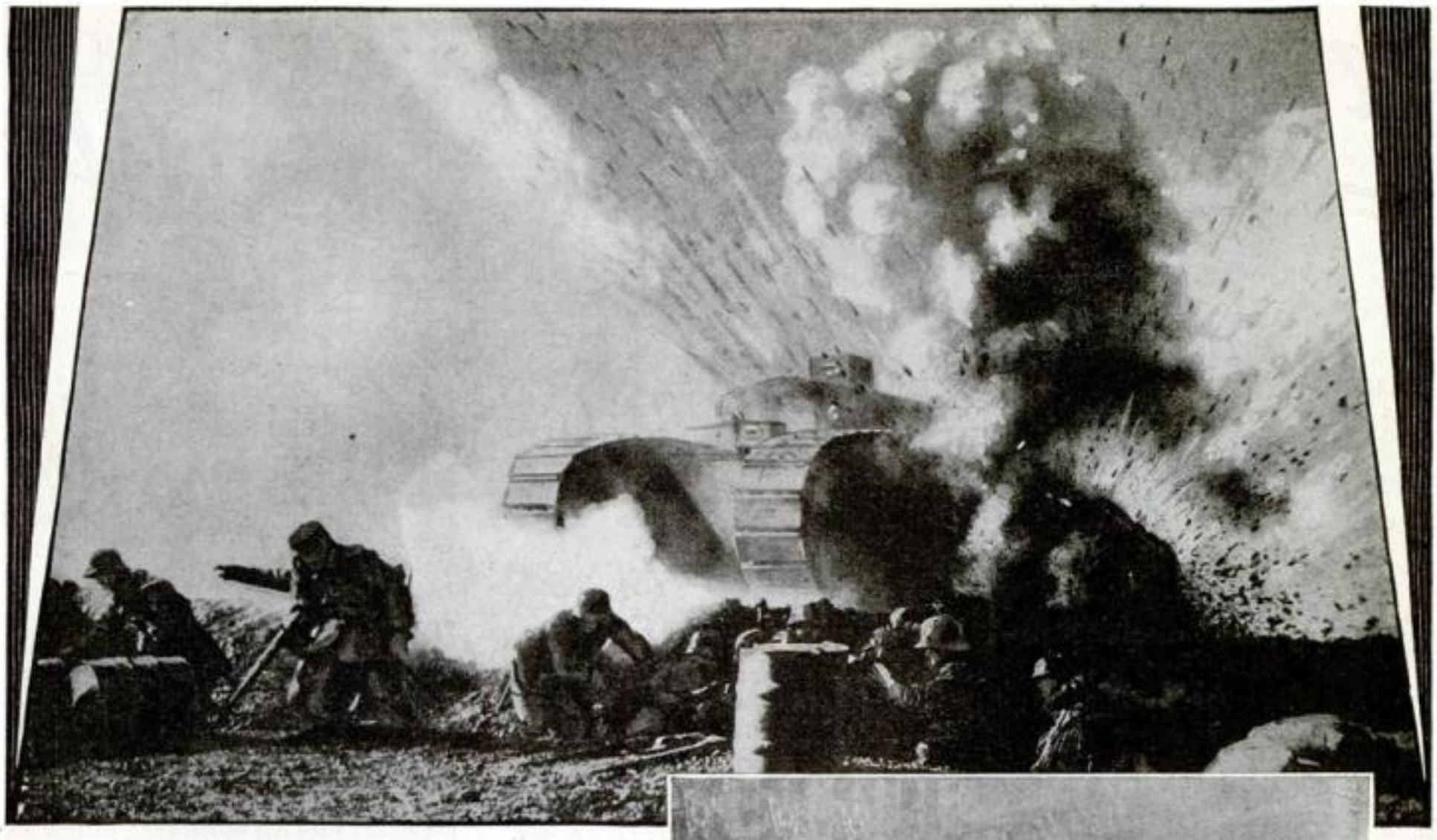

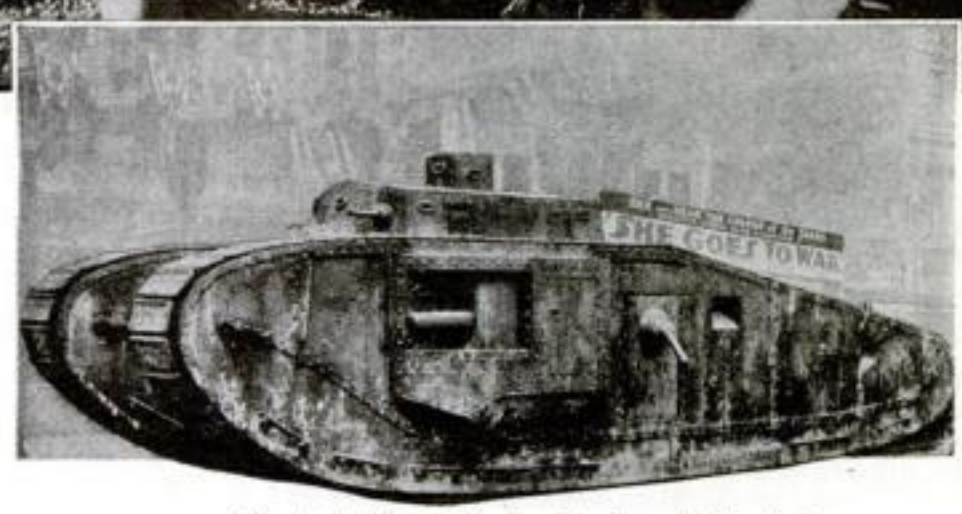

One of the Masonite Presdwood tanks used by Inspiration Pictures, Inc., at the Tec-Art Studios, Hollywood, California.

This tank looks like steel – *but is made of* PRESDWOOD

[If you are interested in any manufactured article, you can probably find ways in which Presdwood will lower your production costs and improve quality. Send for free sample and the Presdwood booklet. Just mail the coupon NOW.]

In both movie studios and factories, Masonite Presdwood is helping to win the war against rising production costs. In monster tanks of the feature film, "She Goes to War", this grainless wood forms most of the superstructure. Here Presdwood is used for its lightness, workability, smoothness, strength, and ability to take any finish.

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Our Readers Say

Try This One

"THE letters you recently published about a problem in airplane speed were interesting. May I suggest another problem for someone with a taste for figures to solve:

"An automobile circles a speedway twice. The first lap is covered at the low speed of ten miles an hour; the second lap at fifty miles an hour. What is the automobile's average speed for the two laps?

"Nine out of ten people, I think, will reply 'Thirty miles an hour.' But that is not the answer. Figure it out."—H. D. F., Oakland, Calif.

Was Ist Loess?

"A R. M., of Detroit, Mich., objected last month to your use of the word 'noninflammable,' which he called 'awkward and confusing'. I must say I don't like the word, either; but in view of its widespread use I can quite forgive anyone who employs it. In fact, I can forgive anything after reading the following from a current scientific publication. Listen:

"'In your May 24, 1929, issue, Mr. Frank Leverett questioned the writer's correlation of the Loveland loess of western Iowa with post-Illinoian, pre-Iowan loess on Illinoian till in western Illinois and southeastern Iowa. Leverett stated that the probable correlation of the Loveland loess of western Iowa is with pre-Illinoian loess rather than with post-Illinoian loess; he considers the Loveland loess to be pre-Illinoian, pre-Iowan in age and not post-Illinoian, pre-Iowan in age as the Loveland has been interpreted to be by the writer. Leverett and the writer agree that the Loveland loess of western Iowa is post-Kansan gumbotil erosion, pre-Iowan in age; we differ as to whether it is the loess which underlies the Illinoian till that is of the same age as the Loveland of Western Iowa . . . ' And so on.

"What I want to know is: did the patient recover?"—J. L., Philadelphia, Pa.

Ask Son; He Knows

"I GET a great kick out of watching my ten-year-old son grab up each new issue of POPULAR SCIENCE MONTHLY as I bring it home. After I have had it a few days, I am sure to find it in his room, as well as back number copies. Do you realize that with radio, airplanes, airships, speed boats, chemistry, etc., the youngster of today is more scientifically minded than we were at that age?"—G. A. U., New York City.

Goddard's Solar Engine

"IT SEEMS to me that Goddard's solar engine, described in a recent issue, will not work for the reason that the back pressure of the steam in the steam generating unit will push the water back, making it necessary for the water pressure to be greater than the steam pressure. The model worked because the steam was free to the air and could not push the water back. If the nozzle was closed on the model, preventing the escape of steam, the steam would push the water back out of the generating unit. The steam would do the same if it was made to work in a turbine, unless the pump pressure on the water is greater than the pressure of the steam.

"It would probably work if there were valves on the water and mercury pipes leading to the generating unit, which would open when the generating unit was empty of steam, and water pumped in. If water flowed continuously in the generating unit, the solar engine would not work."—S. M., Niles, Ohio.

Water is pumped into the boiler of every steam engine now in use in direct proportion to the amount of water turned into steam. Professor Goddard's proposed motor therefore does not deviate from standard practice in this respect.

Give This Little Streamline a Hand

"MR. ARMAGNAC'S recent article on streamlining was splendid. It made me want to talk to him, he knows so much about the subject. When I finished reading the article, I was bubbling over with questions. Aren't our noses examples of streamlining? Aren't our ears laid back against our heads to lessen resistance? My husband thinks such questions are silly. But I think they are scientific."—(Mrs.) E. A. Y., Dallas, Tex.

Certainly

"WHY do you boost the new calendar? Nobody will make a cent more money if he hangs up a thirteen month calendar. Are you planning to give your subscribers an extra copy of your magazine as a premium?"—K. A. O., Brookfield, Ill.

Who'll Help Him Out?

"I HAVE a puzzle that concerns almost every amateur shop worker. Can two one-quarter-H.P. motors be coupled together on the same circuit to work on the same machine together with greater efficiency than one motor alone? My own experiments have been unsatisfactory. I have two motors, plugged into different sockets. Either one alone will run a band saw, but I frequently need more power. When I attach both of them to the saw how much additional power should I expect to get?"—A. E. W., Ada, Ohio.

A "Pausible" Reason

"I WON'T subscribe to your magazine, and this is the reason why: I like your magazine so much that I can't wait for it to come by mail, and another thing, they sometimes, perhaps unavoidably, arrive with torn covers; and worse than that, the way you roll them for mailing, I can never get them flat again. I demand that there must not be a wrinkle, scratch, or smudge on any Paus cover design, because I save every one of them, and guard my collection carefully.

"To insure getting my copy as I want it, I buy it at the first news stand where I see it displayed, on the first day it's out. That's that, and I thank you."—R. A. K., Amityville, N. Y.

One Tough Lizzie

"THIS is an answer to the challenge issued by A. M. D., at Lansing, Mich. who claimed the world's, record for automobile ownership, having driven eight cars, each for more than 25,000 miles. He don't even know what mileage is. We got an old Ford out in the great goldfields at Carrara, Nevada, that hauls ore, supplies, and passengers, and we got 296,413 miles out of her now, and she is still running a daily schedule from Carrara to Las Vegas, Nevada. We may use her to help build the Boulder Dam, but we must admit we have bought five new steering wheels for her, as when we wear one down as thin as a lead pencil, we put on a new one."—A. S., Carrara, Nevada.

A Huge Family

"I AM exceedingly glad to hear that you are improving your Home Workshop Department—it's the one I like best of all.

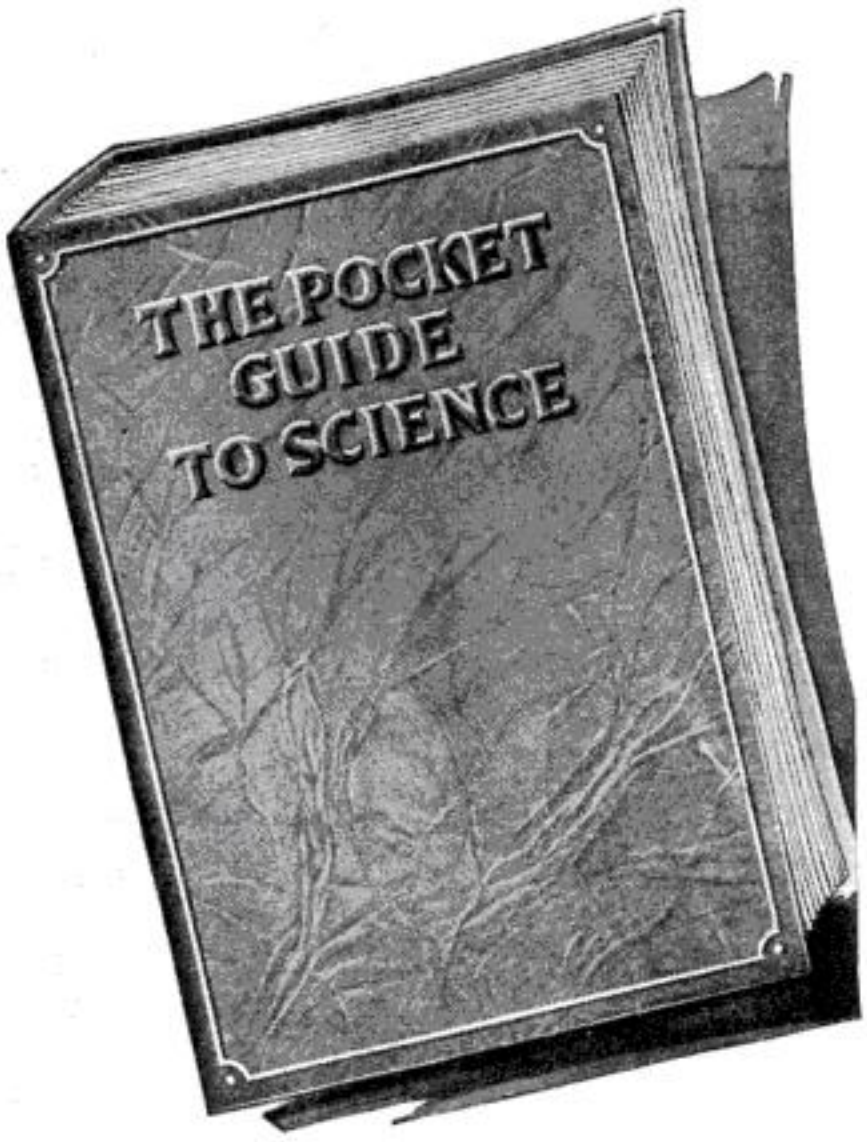
"It makes me smile to read some of the criticisms on the 'Our Readers Say' page. How can some fellows be so dumb, imagining that the magazine should not print anything which is not to their particular liking? The fact does not penetrate that the good old 'Mag' is trying its best to please thousands upon thousands of readers, of every age, sex, and temperament.

"I cannot imagine any other magazine—taken from every point of view—which provides more interest and gives more all around satisfaction than POPULAR SCIENCE MONTHLY, BAR NONE, and that's no soft soap either. POPULAR SCIENCE MONTHLY is part and parcel of my existence. I feel like one in a huge family and I wonder if other readers have the same feeling?"—E. B. R., Regina, Sask., Can.

Some Boat

"WITH the aid of my son-in-law, I have recently finished building the outboard motor boat described in your June, 1929, issue. This was my first experience at boat building, but from the results achieved I think it only proper to let you know what we think of your efforts to furnish reliable detailed plans to work from.

"We followed all instructions, except we moved all stations one inch closer together than specified in your plans. We did this as we could not conveniently buy cypress boards longer than sixteen feet and we did not want to have joints in the boat. We have a forward deck covering five stations. Bottom, sides, and deck are of three-eighths-inch clear cypress.



INTO THIS one brilliant book of 280 pages have been condensed the outstanding facts that scientists have discovered since Aristotle, the father of science, dissected a frog to see what made its heart beat.

How often have you wanted to know about the wonderful discoveries in science that have so changed the world we live in . . . the secret of radium . . . the romance of the atom . . . the origin of the earth!

Or you may have wanted to know why glass is transparent . . . how fireflies produce light . . . why the grass is green . . . if radio waves move in a straight line?

All of these questions, and hundreds of others, have now been answered, for the first time, in one book—THE POCKET GUIDE TO SCIENCE.

All that you probably will ever want to know about science is told in this one book that will fit in your pocket or grace a library table. The curiosity-satisfying facts about the world we live in are made instantly available to you in simple question-and-answer form in THE POCKET GUIDE TO SCIENCE.

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-on this Wonderful Book

YOU are assured of the accuracy of the answers in THE POCKET GUIDE TO SCIENCE because it has been edited by Dr. E. E. Free, the distinguished author of "The Story of Man and His World." Dr. Free has a remarkable genius for condensing the known facts about scientific questions into vivid, easily remembered paragraphs.

SPECIAL OFFER

THE POCKET GUIDE TO SCIENCE is not for sale. It is offered to you *without one penny extra cost*, with a 14 months' subscription to POPULAR SCIENCE MONTHLY.

In THE POCKET GUIDE TO SCIENCE you get full information of all that the scientists have discovered up to the summer of 1924.

POPULAR SCIENCE MONTHLY "carries on" where THE POCKET GUIDE TO SCIENCE leaves off. The POCKET GUIDE gives you all the information up to right now—POPULAR SCIENCE MONTHLY will give you all the important, interesting and new discoveries of science for the next 14 months.

In every issue of POPULAR SCIENCE MONTHLY are a dozen or more important articles that explain and picture the most fascinating and significant new developments, discoveries, and undertakings in exploration, in engineering, in health, in electricity, in medicine, and in every branch of science.

And there are also, in every issue, a hundred or more articles describing the important new inventions in every branch of mechanical activity—page after page filled with photographs and descriptions that show you how you can save money in the shop, around your car, in your store, office and home.

But all this is only part of the contents of one issue of the amazing POPULAR SCIENCE MONTHLY. It takes over 300 articles and pictures every month to tell the readers of POPULAR SCIENCE MONTHLY all that has happened in the scientific, radio, mechanical, and automotive fields.

A Few of the Hundreds of Questions Answered in the POCKET GUIDE TO SCIENCE

Why does static interfere with radio messages?
What gland makes people grow tall or keeps them short?
Why do we grow old?
What is the safest stimulant?
What is the function of the liver?
Why are tears salt?
Can energy be destroyed?
Why can't you skate on glass if it is smoother than ice?
How do self-winding clocks work?
Why does an iron ship float?
Can we see atoms with a microscope?
What are electrons?
Is electricity a form of matter?
What is a crystal?
How large is the universe?
Why do the stars twinkle?
How do we know what the stars are made of?
Is the inside of the earth molten?
What is an electric spark?
What makes the noise of thunder?

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You are offered a 14 months' subscription to POPULAR SCIENCE MONTHLY (regular price if bought by the month would be $3.50) with THE POCKET GUIDE TO SCIENCE—all for $2.95, plus the few cents' postage. If you are already a subscriber to POPULAR SCIENCE MONTHLY we will be glad to extend your subscription 14 months if you accept this offer.

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I accept your offer of THE POCKET GUIDE TO SCIENCE and a 14 months' subscription to POPULAR SCIENCE MONTHLY. I will pay the postman $2.95, plus the few cents' postage when he delivers the POCKET GUIDE and the first issue of POPULAR SCIENCE MONTHLY. If the book and magazine are not fully satisfactory to me I will return them within 10 days and you are to promptly refund my full payment. Please stamp my name in gold.

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Address.....

City..... *State*.....

1-30

"When we turned it over after putting the bottom and sides on the frames, it balanced so perfectly on its keel or shoe that by putting a one quarter by two inch bolt in the boat on either side we would overbalance it.

"On the water it has given more speed and performs better than was expected. Whoever it was that drew the plans and wrote the specifications sure knew their business, and if convenient you may thank them for me and also for my son-in-law. I have not missed reading POPULAR SCIENCE for several years. Thank you for the plans."—M. H., Memphis, Tenn.

Which Is Right?

"PLEASE tell Gus Wilson for me that he's all wet. Some high-powered automobile salesman has been calling at the Model Garage. That much is written all over Martin Bunn's latest screed entitled 'Where the New Motor Cars Excel.'

Granted the new models may have all kinds of novel thingamajigs like four-speed transmission, down-draft carburetor, thermostats, or what have you. The fact remains that they simply don't stand up like the older carts do, and I challenge anyone to prove otherwise.

The reasons are plain: The costs of material and labor have been advancing every year. The prices of cars have been just as steadily declining. Yet the automobile manufacturers are making more money than ever.

"There can be only one answer—a skimping of materials and workmanship in manufacture. This skimping shows up in every bone and joint of the new cars. Why, the other day a neighbor called me over to his garage to see his new car. He certainly was sore. He pressed his thumb against the paper-thin body and left a dent in it (the body). When he slammed the door it sounded like dropping a dishpan. My ageing crock, built in 1924, has now traveled nearly 40,000 miles without a major repair and without a rattle. I'd like to see any one of the cars of the last two years stand up that well for ten months of driving.

"This fellow Kellogg in Martin Bunn's story is simply a poor sap. He let them asphyxiate his weak mind with a lot of catalogue hooey, and gave up the ship without a murmur."—H. L., Jr., Columbus, O.

Send Them Along

"INCOME-TAX forms are a nightmare to me. Reports of a company's earnings give me a headache. Well-meant Government bulletins explaining the prevalence of the tsetse-fly or reporting the latest census in prime movers fill me with horror. I run and hide when anything statistical comes my way.

"Imagine then, gentlemen, my sensations when in my favorite POPULAR SCIENCE MONTHLY, December, page fifty-two, what do I see? Naught else but a graph, stark and unashamed, rearing its nasty head.

"Now, gentlemen, one of the things that I have always admired about your admirable journal is your ingenuity in finding appropriate and interesting photographs to bring home your points. Please keep it up. I'll make a note to send you a box of camera plates for Christmas."—G. B. H., Montclair, N. J.

A Real Menace

"WE WISH to compliment your magazine on publishing the fine article entitled 'Dangers in Driving with Bad Eyes.' It ably presents the matter in a convincing manner. Those who practice optometry (a profession specializing in the diagnosis and correction of defective vision) have for some time been fully aware of the dangers of defective vision among motor vehicle operators, and we feel that you are doing a good job in the promotion of the public welfare by thus ably discussing the matter."—Vermont State Board of Optometry.

Maybe a Doll Would Do

"LARRY BRENT said, when making his first solo flight, that the front cockpit looked larger and emptier than a Zeppelin's shed. Why not put a wax dummy in the front cockpit, or even cover it up, when making the first solo flight? That cockpit wouldn't look so empty then."—R. C. C., Jr., Yukon, Fla.

Perfectly Simple

"AS THERE is still so much controversy concerning the evolution of man, and so much still unsettled and unknown, why don't advocates of the evolution theory get the scientists to procure one of those sea worms mentioned in the November number of P. S. M., page twenty-one, column three; take one of these spineless sea worms from which man originated into their laboratories; turn the X-rays, radium rays, and cosmic rays on it in full force; and *produce a new man*, thus proving their theory practicable? If they will do this, then it will settle the matter. What those rays *have* done, they can do *again*. So let them get busy and show how man got here."—F. C. C. C., Flint, Texas.

On Opening Cans

"I HAVE been reading POPULAR SCIENCE MONTHLY for about three years continuously, and never saw a letter on 'Our Readers Say' page which I knew to be more correct than the one entitled 'Here's Another Worry.' After opening a can with the ordinary can opener, I have often noticed the tiny particles of metal mentioned. I always remove them and have found the following method the best:

"After completely removing the top of the can, take a teaspoon and scrape the inside of the can where it has been cut. This removes small particles hanging on the edge which get into the contents when pouring it out. Then scrape the top of the contents of the can before dumping. Yours for the benefit of your readers."—B. W. L., New York City.

Another Prize Winner

"MY MODEL of the *Spirit of St. Louis*, built from plans in your magazine, won first prize for duration R. O. G. in Boston."—B. W., Cambridge, Mass.

An Airplane Puzzle

"ONE of your writers says that the pressure on the underside of an airplane wing accounts for only one third the total lift on the wing. The curved surface makes a vacuum on top, he says, and this vacuum 'pulls' up two pounds for every one 'lifted' by pressure on the bottom of the wing. All that writer needs to do to see he is wrong is to watch an airplane fly upside down. Then the vacuum is on the underside, pulling down two pounds for every one supported by the wing surface. The lift is less than nothing. Why doesn't the airplane drop to the ground?"—R. A. L., New York City.

Anybody Else? Speak Up

"MANY of your readers are tired of having articles continued in a mass of ads. They will not take the trouble to tell you why they drop it, as I have."—W. C. S., Brooklyn, N. Y.

Popular Science in India

"WE ARE conducting an industrial training school for Indian Christian young men and boys. There are three departments in the school—carpentry, blacksmithing, and tailoring—and we expect to open another department for the training of motor mechanics next year. We hope to make the school the center of industrial education for this section of India. Our carpentry and blacksmith shops can produce very high grade articles, so you can understand why we make good use of various articles which appear in the POPULAR SCIENCE MONTHLY.

"I hope that when we are on furlough in 1934 we shall have the opportunity of calling at the Institute office and securing some of the plans you have been advertising. We certainly wish to have the magazine continuing to come to us, for it is a source of pleasure as well as one of profit."—E. L. P., Saharanpur, India.

Fields for Experiment

"RELATIVE to E. E. Free's very interesting article on cosmic rays as a possible clue to evolution, the following may not be new thoughts, but if they are, why not pass on the suggestions to the experimenters?

"Has the negative aspect been studied, such as breeding the fruit flies in an environment not subject to any known rays . . . presumably a lead chamber?

"Has cancer propagation (they use rats, don't they?) been tried under above conditions and compared with results under normal conditions? Such experiments should give definite results.

"Has a relationship been suspected between radioactivity and vitamins? Seems probable, and could be studied effectively by the above negative method."—V. W. M., Quebec, Canada.

SO FAR *as we know fruit flies have not been studied in an environment shielded against radium and similar rays. There would be serious difficulties, especially in introducing necessary food, light, etc., without also admitting radiation. These difficulties are not necessarily insuperable.*

The matter of testing rat cancers with and without general radiation, such as cosmic rays or radium rays, has been suggested, notably by Prof. Joly. It is said that this is to be done at the Cancer Institute in Liverpool. Certainly it will be done somewhere.

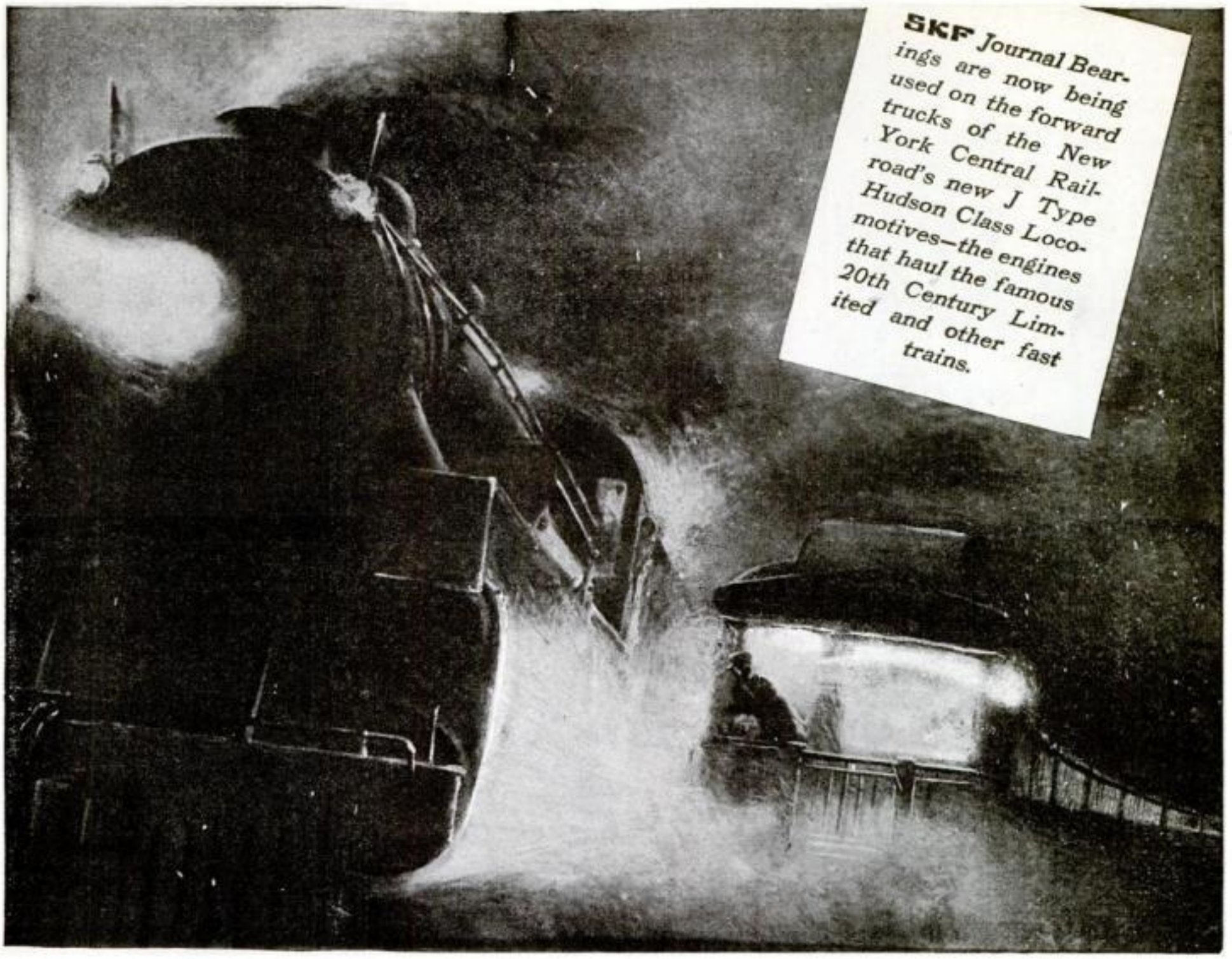
The possible relationship between vitamins and radioactivity has also been thought of. We understand that experiments are under way under the auspices of the Medical Research Council in London. So far as we know, no tests are being carried out in the United States.

In a Nutshell

"MIGHT I suggest in connection with your Home Workshop Department that an index would be appreciated, as it is a great deal of trouble when you wish to find something in a hurry to go through the pages one by one."—W. J. S., Springfield, Mass.

"I was delighted to read Mr. Fairchild's article 'You Don't Have to Be a Pilot'. One can learn a lot about aviation by merely reading an article of this kind. Please publish more of this type."—L. K., Brooklyn, N. Y.

"Your articles by Martin Bunn are very interesting. A person enjoys such writings because he might have similar trouble on the road and save a few dollars by fixing the trouble himself."—E. G., New Buffalo, Mich.



Let her *Ride*, Mr. Engineer, let her *Ride*!

THERE she goes—hurtling her tons of iron and steel and humanity through the night—roaring her way along the rails—turning the minutes into miles. Now on the straightaway—now leaning to the bank of the curve—following the lead of her forward trucks! Let her RIDE, Mr. Engineer, let her RIDE.

A real job for bearings that—up ahead on the forward trucks where wheel flanges grip the rails and change the direction of tons of hurtling, swaying steel. But let her RIDE, Mr. Engineer, let her RIDE.

Those bearings on the forward trucks are SKF Bearings—built *up* to the job and not *down* to the price—They're "The Highest Priced Bearings in the World". Let her RIDE, Mr. Engineer, let her RIDE.

* * *

If *you* design, build or buy anything that runs on anti-friction bearings, it's well to remember that while you *can* always buy a bearing at a bargain, you'll never get a bargain out of USING it.

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The Highest Priced Bearing in the World

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The living room, too, is fully protected from all extremes of temperature with ***Celotex Lath, designed to eliminate lath marks and plaster cracks.***

The walls of this attractive bedroom are plastered over Celotex Lath, so that the room keeps comfortably warm in winter and delightfully cool in summer.

This unusual dining room has walls and ceilings that shut out the bitter winter cold ***for they are smoothly plastered over Celotex Lath, the cane-fibre plaster base.***

You buy *milder winters and cooler summers* when you insulate your home with Celotex

PEOPLE who complain about bitter winter weather usually mean that their homes are hard to keep warm. They are living in old-fashioned, uninsulated houses.

But nowadays it's easy to line roofs, walls and ceilings with Celotex and keep every corner of the house warm and comfortable. This remarkable cane-fibre insulation shuts out all extremes of temperature—keeps furnace heat from leaking away—and in years to come saves hundreds of dollars in fuel bills.

And in summer Celotex stops the scorching sun's rays . . . keeps every room cool and pleasant.

You want the wonderfully increased comfort that comes with Celotex—and the splendid fuel economy it insures. There's no reason why you should hesitate to enjoy them.

For it is not a long, expensive job to remodel with cane-fibre insulation. Celotex comes in big, strong boards that build as well as insulate—add structural strength to walls and roofs. And for plastered interiors there is Celotex Lath—an insulating plaster base designed to reinforce plaster against cracking and eliminate lath marks.

When you build or buy a new home, insist upon Celotex insulation. But don't wait until then. Make the home you are living in now more comfortable, more healthful the year 'round, this easy and inexpensive way.

Thousands of families are lining their attics with Celotex—are building pleasant new rooms out of wasted attic space—insulating garages, protecting basements from cold and dampness.

Call in your architect or builder and talk things over with him. He'll gladly give you an estimate on the Celotex insulation your home should have, together with many more facts that are sure to interest you.

The Celotex Company, Chicago, Illinois. (Member of the Home Modernizing Bureau of the National Building Industries, Inc.) In Canada: Alexander Murray & Co., Ltd., Montreal. Sales distributors throughout the world. Reliable dealers can always supply Celotex Standard Building Board and Celotex Lath.

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Popular Science MONTHLY

JANUARY, 1930 TRAVIS HOKE *Editor* VOL. 116, NO. 1

The World Must Outlaw Noise

Each new invention of modern engineering seems noisier than the last. On city streets people already are from one third to one half deafened by noises.

Great Cities, Menaced by Deafening Din of Modern Inventions, Move to Safeguard Public Nerves and Health

By E. E. FREE

DOES noise endanger civilization? Not even noise-haters have suggested so drastic a query, yet they might do so without exceeding the possibilities. Recent psychological tests have shown that one of the effects of noise may be to over-stimulate the body, nerves, and mind. City dwellers of Europe and America are already too numerous and active, many critics believe, for their own good. Increasing noise may be one cause of this. If it is, no good is promised, for city noises show no sign of decreasing. Rather, unless public action promptly limits it, noise will increase.

Each new invention of modern engineering seems noisier than the last. On city streets people are already from one third to one half deafened by the average noise. No less an authority than Thomas A. Edison has predicted that sooner or later increasingly noisy cities will end by deafening all of their citizens permanently.

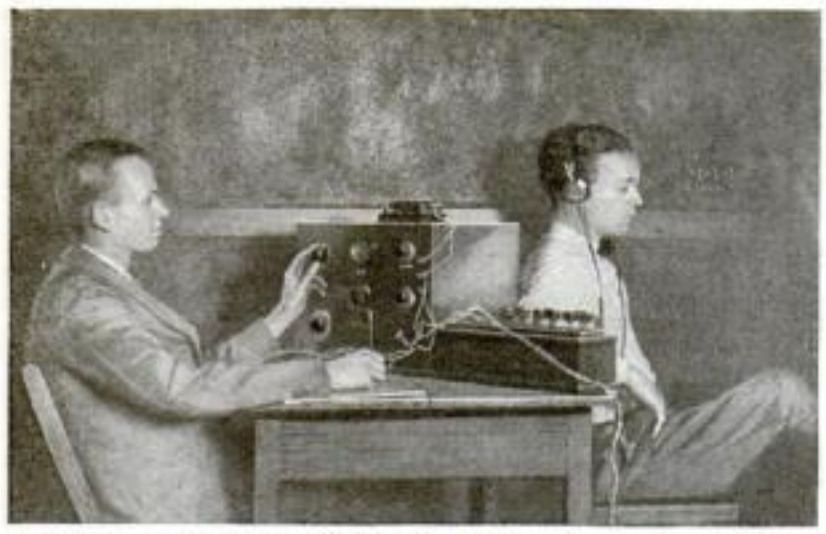
In New York, Chicago, London, Berlin, Paris, Budapest, and dozens of other cities officials or commissions are seeking means to lessen noise. Three American scientific societies have noise committees at work. Prominent psychologists are trying to discover precisely what harmful things noise does to human minds or bodies.

Mankind will not be killed by noise. A species that survived the cave tiger, the mammoth, and the Great Ice Age is not so easily disposed of. But that complicated system of balances and coöperations called civilization is far more fragile than humanity, as its collapses in the past have proved. Too much average nervousness might kill it, as might too much apathy or too little ambition. And feverish, overstimulated nervousness might easily be one effect of continual noise.

The present world-wide agitation against noise is not the first one. A generation ago a New York woman, Mrs. Isaac L. Rice, initiated an antinoise campaign that resulted in at least three definite reforms: the suppression of street cries by peddlers, a decrease in whistling by boats in New York harbor, and the institution of zones of quiet around hospitals. The first and last of these regulations have become all but universal in American cities.

But gradually have come new noises such as riveting, siren-blowing, fire engines, and perhaps worst of all modern offenders against city quiet, the radio loudspeaker. Thousands of violent letters of protest have been received by New York City newspapers, health officers, and noise experts in the last few months against the needless nuisance of the radio loudspeaker playing on the street or audible outside the owner's home.

Concerned by these newer sources of city noise, as well as by the gradual growth of noise due to street traffic, Dr. Henry Goddard Leach, a New York City magazine editor, undertook, four years ago, a new antinoise agitation, just now reaching its fruition in action. At Dr. Leach's request, my laboratory made a noise survey of New York City, determining the amounts of noise on various streets at various hours of the day and something concerning its sources. A similar survey was made a few months later in Chicago. In London, street noise observations and a survey of noise in the Underground Railway were made by Professor A. M. Low. Committees on the elimination of noise were organized by the National Safety Council and also by various



Psychology students of Princeton University testing fatigue effects of varying noises produced by an electric oscillator. Experiments indicate that loud noises use up energy of the body.

other social and technical institutions.

The agitation has gathered momentum. Irked by a statement that it was the noisiest city of Europe, Budapest, Hungary, established a "noise squad" of police to arrest every person found producing unnecessary noise. In Berlin, a campaign was waged last summer against noisy motorcycles. Paris has begun agitation against unnecessarily noisy automobile horns. In London, an antinoise code has been formulated for enforcement against trucks or automobiles with loose and noisy parts, excessive engine noise, unnecessary horn blowing, and so on.

Only a few weeks ago, Dr. Shirley W. Wynne, Health Commissioner of New York City, took the most definite step yet attempted anywhere for the general restriction of noise in a major city area. On the ground that excessive noise menaced the city's health, Dr. Wynne appointed seven citizens to serve without pay on a Noise Commission, in the effort to devise practicable ways of making New York City, if not a noiseless town, at least one less continually nerve-racking than it is today. The plan at once received the active coöperation of executives of many of the city's influential business and civic organizations.

One of the first moves in the Commission's program was a thorough analysis of the noises that plague various areas of the city. Two methods are being employed. First, a truck equipped with noise-testing apparatus measuring the relative intensity of sounds in different districts is daily making its way through the city streets collecting first-hand evidence. Secondly, a questionnaire has been published for all citizens to fill out, indicating thereon the specific noises which vex their neighborhoods at specific hours. From every civilized city in the world the eyes of experts and of long-suffering noise haters will be on Dr. Wynne's Commission to see what practical remedies can be applied without too grave objection from citizens whose businesses are interfered with.

This matter of interference with business is the worm in the noise engineer's apple. Any competent expert could make almost any city practically noiseless in a week. The difficulty is that his procedures, like stopping noisy traffic or preventing building, would throw the majority of citizens out of jobs and half starve the rest. To decrease the average noise of New York City by three fourths would increase the average cost of living in the city by at least twenty percent. Few people would consider that worth while. The practical problem which confronts organizations like Dr. Wynne's Commission is to select the noises of modern civilization which can be eliminated with minimum cost and with maximum benefit to the majority of the people.

The first problem is to define a noise. To the physicist, noise is any mixed, complicated sound. A golden twenty-dollar piece held by its center and struck along its edge sharply will give a clear, bell-like ring. Physically, that is not noise, but a musical tone. If twenty such gold pieces are put in a box and shaken, the result is a mixed sound composed of all twenty diverse rings plus other sounds from the box. That is a noise. One wine glass, if struck, gives a musical note. Dropping a tray of them produces a crash. Regular, single tones are music. Irregular or complicated ones are noise.

The layman's definition of noise is broader. It may be defined as "sound out of place." A near-by radio or a brass band in the street may be musical enough. Nevertheless, to a person trying to sleep or to concentrate his mind these may seem among the worst kinds of noise. The selection of noises to be eliminated will take more account, of course, of this common definition of noise than of the physical one.

Many technical facts which must underlie such efforts are available. The noise survey of New York City indicated that nearly all of the noise is due to traffic. (About forty percent of the average noise on a typical, noisy New York street corner was traced to automobile trucks. A further twenty-five percent originates from the elevated railway.) Surface electric cars account for about twenty percent, making a total of about eighty-five percent of all New York's noise traceable to these three noise makers alone. Only fifteen percent of average din is left to be supplied by other noise makers, some of which may be, however, very annoying to near-by individuals, if not numerically important in the totals. Among these are automobile horns, fire engines, street cries and whistles, riveting and excavating machinery, railway engines, tugboats, the clangor of loudspeakers, and all the rest.

In other cities these percentages probably are somewhat different. Absence of elevated railways and the use of busses instead of surface electric cars reduce city noise substantially below New York or Chicago levels, increasing correspondingly the percentages due to trucks and other automobiles. Perhaps a fair general average for the congested portions of typical American cities would be to charge about three fifths of the noise to automobile trucks, about one fifth to street cars, and the remaining fifth to excavation, automobile horns and other miscellaneous sources.

"IF CIVILIZED pedestrians shouted insults at each other in the same mental attitude in which the average automobile driver toots his horn," says Dr. Free, "the daily American average of black eyes and punched noses would show a startling increase." A leading authority on sound, he tells here how needless clamor affects human vitality, and suggests possible ways in which much of the din may be quieted.

Obviously, few of these major noise makers can be abolished altogether. Is it possible to make any of them less noisy? New York City tests show that it is. Most automobile trucks, for example, range from five to twenty times noisier than pleasure cars. Yet some trucks are scarcely noisier than pleasure cars. The chief cause of the difference is carelessness, either of the truck manufacturer who did not trouble to make his mechanism relatively noiseless, or, more often, of the truck owner or driver who does not take care to have his vehicle properly serviced at frequent intervals.

Five years' study of city noise problems has convinced me that one simple regulation denying the city streets to any vehicle, horse-drawn or automotive, having any loose or rattling part would decrease city noise, except perhaps on street car streets, by at least fifty percent. Combined with a few equally reasonable regulations about public loudspeakers,

British experts, with elaborate sound detecting instruments, record various underground noises in a London subway station.

useless tooting of automobile horns, mufflers on excavating machinery and the like, this would reduce the noise of most cities to quite tolerable levels with scarcely any cost or business interference. The servicing of trucks, automotive experts report, probably would more than pay for itself in lower upkeep and longer life.

THERE would remain the problem of machine noise; one so important to the industries and professions concerned that it is now being studied on behalf of the American Society of Mechanical Engineers by a committee headed by Dr. William Braid White of Chicago. Some of the most annoying household noises are of this machine type; those from elevator motors, for example, or from pumps or refrigerating machines in one's own house or a neighbor's. To eliminate these is a big job for the noise engineer; to measure them adequately is scarcely less difficult.

Suppose, for example, that a manufacturer installs some kind of machine under the promise that it will be noiseless. Afterward the purchaser claims that it is not noiseless. Who is to decide? How is the disputed "noiselessness" to be measured? It is obvious that complete silence cannot have been meant, for no running machinery is that, not even a watch. In offices there is the similar problem of the so-called noiseless typewriters, machines which even the makers do not pretend to be absolutely silent but merely less noisy than other types. In homes, the vacuum cleaner or the oil-burning furnace is an example of machine noise about the annoying qualities of which people differ vastly, and which is still difficult to measure accurately.

The trouble is what might be called a variation in the noisiness of noise. The human ear is not equally sensitive to all kinds of sounds. Low-pitched ones, such as the lowest tones of the piano, must be relatively strong to be heard and recognized. Nor does the average ear hear very high-pitched tones well. There is a point of high pitch, in fact, at which the ear ceases altogether to hear the sound. Intermediate tones, about at the middle of the upper third of the piano keyboard, are heard best of all. If a deep bass, a high treble, and an intermediate tone are equally loud when measured in physical units, the intermediate tone will seem much louder than the others.

These facts must be taken into account in measuring noise. An American engineer recently "took the noise out" of a well-known make of automobile engine simply by lowering the average pitch of the tones which the machine was singing. Measured in physical units, the total amount of sound emitted remained much as before, but it was composed of lower-pitched tones to which the ear is less sensitive.

That is an example of a noise relatively little noisy. A reverse example would be a noise pitched at the point where the ear is most sensitive. For the same actual strength of the sound, such a noise as this will seem to be more noisy than others.

The cowbells of the junk wagon have no place in the modern city, while the noises let loose by midnight handlers of ash cans are prohibited by nuisance ordinances already.

The recently-organized Acoustical Society of America, the United States Bureau of Standards, and several private agencies have taken up the problem of measuring the kinds and amounts of noise that get through the walls and floors of houses or that reverberate inside noisy rooms. Enough is known already about these problems to permit anyone willing to pay the price to build, in the noisiest spot of the noisiest American city, a room or house so noise-proof that its interior is as quiet as a primeval wilderness. Materials which have been devised for treatment of walls and ceilings to reduce the noise in offices full of typewriters are also efficient and successful. R. F. Norris, of the Burgess Laboratories of Madison, Wis., has even developed sound-absorbing methods for air shafts and window ventilators, so that fresh air may be admitted continually without letting in more than a dim ghost of the outside noise.

Perhaps the worst of all offenders against city quiet is the radio loudspeaker playing on the street. It could be easily suppressed.

The great questions which scientists still must answer about noise are psychological ones. Which noises, if any, are really harmful to the human system? To what extent can one get used to noise? Which noises are stimulating and under what circumstances? Is this stimulation good or bad? And so on. More than ten years ago, at Columbia University, Professor John J. B. Morgan made preliminary studies of noise effects on the human body. He concluded that continual loud noises apparently force the body to use more energy, consume slightly more food, and breathe more oxygen. The whole energy-using and energy-producing mechanism of the human system seems to work, under noisy conditions, at a slightly faster rate.

PROFESSOR MORGAN, now at Northwestern University, is continuing these experiments with the support of the noise committee of the National Safety Council. At Columbia University, Professor A. T. Poffenberger is carrying out other experiments to test this same matter of the relative use of body energy in noise and in quiet. In similar tests at Colgate University, Professor Donald A. Laird found that work under noisy conditions made his experimental subjects more tired than when they worked in quiet.

At Ohio Wesleyan University, Professor F. C. Dockeray, however, has uncovered evidence of stimulation by noise; of what have been nicknamed "noise cocktails." Testing the speed and accuracy of students doing mental work in noisy and quiet surroundings, Professor Dockeray finds that noise, if not too loud or too long-continued, has a small average advantage over quiet. Apparently, the noise keeps the student more alert or spurs the brain to a little faster activity. This conclusion agrees well enough with the idea of Professor Morgan that noise increases the use of bodily energy, and with that of Professor Laird that it increases fatigue.

EVERYTHING fits with the idea that noise may act as a nervous, bodily, and mental stimulant. To a person who is naturally sluggish and unambitious, a noisy city may be a great benefit, like a heart stimulant to a man whose bodily machinery works too slowly. To a person already alert and nervous, on the other hand, Professor Dockeray's "noise cocktails" may pro- (Continued on page 129)

What Science Achieved in 1929

Authorities in Seventeen Fields of Research Take Stock of the Year's Outstanding Advances in Discovery and Invention

COMMUNICATION

FRANK B. JEWETT, Ph. D.
President, Bell Telephone Laboratories

IMPROVEMENTS in apparatus, circuits, and methods continue to extend the limits of communication and to improve its speed, quality, and dependability. Illustrative of this is the proposed transatlantic telephone cable, the main link of which will probably extend 1,800 nautical miles from Newfoundland to Ireland. This project has been made possible by many inventions and developments, chief of which are a new alloy, perminvar, used to "load" the copper conductor in the cable, and a new insulating material known as "paragutta."

Increase from 1,200 to 1,800 in the maximum number of pairs of telephone wires which can be placed in a standard-sized cable sheath, improved switchboard and private branch exchange equipment, improved textile insulation for wire and apparatus, experimental telephone typewriter exchange service, improved methods of intercity telephone cable construction, and accomplishment of television in colors are other developments.

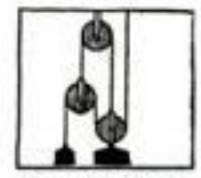
CHEMISTRY

HUGH S. TAYLOR, D.Sc.
Professor of Chemistry, Princeton University

INTENSIVE development in this country, on a large industrial scale, of the hydrogenation of crude oils to give larger yields of gasoline is the achievement of greatest significance in chemical technology for the future general welfare. It has as its objective the production of two or three units of motor fuel where only one was before available. It again postpones the dread day of shortage in transportation facilities.

In theoretical chemistry the most important advances of 1929 have come from the borderland between physics and chemistry. Bonhoeffer and Harteck in Berlin have demonstrated that molecular hydrogen consists of two distinct modifications present in normal hydrogen in a 1:3 ratio but convertible to the one form, parahydrogen, at the temperature of liquid hydrogen. This discovery increases the confidence to be placed in the theories from which the experiment sprang and suggests a more intimate picture of atomic structure. The discovery by Giauque, Johnson, Birge, and King in Berkeley of two hitherto unsuspected isotopic forms of the elements oxygen and carbon, by an analysis of their spectra, constitutes another notable advance.

PHYSICS



PAUL R. HEYL, PH.D.
Physicist, U. S. Bureau of Standards

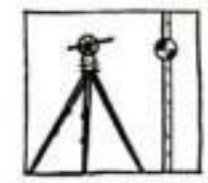
THE theoretical development which has attracted the greatest attention is undoubtedly Einstein's latest contribution to the theory of relativity. In this paper Einstein found a way of linking gravitation with electricity and magnetism, a thing which had been often and unsuccessfully attempted. Einstein succeeded because he did not attempt a direct cross linkage, but traced both classes of phenomena back to a common ancestor.

In atomic physics there have been discovered two new modifications or isotopes of oxygen and one of carbon. These discoveries are claimed by physics, as they were made by physical methods.

Dr. Abbot of the Smithsonian Institution has constructed an exceptionally delicate radiometer with vanes made from the wings of a fly.

At the other extreme in flying mechanisms, we may mention the first long distance flight of an airplane driven by a Diesel engine burning fuel oil. With gasoline at twenty-five cents a gallon this achievement may seem at present of academic interest only, but gasoline will not always be plentiful. Perhaps only a decade hence many such ships will be in the air.

ENGINEERING



COLLINS P. BLISS, M.A.
Professor of Mechanical Engine ring, New York University

FORMAL opening of the eight-mile Cascade Tunnel, the longest railroad tunnel in the United States, ushered in the engineering year of 1929.

Outstanding engineering projects of the year include the great International Bridge at Detroit, longest suspension bridge in the world; the Hudson River Bridge at New York City; the Pacoima Dam in southern California, 385 feet high, and the even higher Diablo and Owyhee dams in Washington and Oregon, respectively. Preparations are going forward for the monster of them all, Boulder Dam in Colorado, a power and flood control project at last assured.

Completion of the great waterway lock system on the Ohio River from Pittsburgh to Cairo adds another link to America's inland waterway system. Mississippi flood control, called the world's largest dirt-moving job, is well under way.

The Woolworth Building's long-standing supremacy among skyscrapers passes at last with the erection of two even higher buildings in New York City, expected to be nearly or entirely completed this year. Another skyscraper planned for Chicago is to dwarf even the Eiffel Tower in Paris. Two-hundred-story buildings are foreseen.

Progress in electrical engineering is typified by such huge electrical machines as the two monster 160,000-kilowatt generators installed early this year at the Hell Gate power station in New York.

An innovation in the field of mechanical engineering are the new steelless alloys of extraordinary hardness for machine tools. Novel forms of power, jet and rocket propulsion, have been tried out in experi-

ments, notably in Germany, for automobiles and airplanes. Here and abroad electric power continues to furnish the driving force in factory machinery. The ubiquitous Diesel engine is finding such new uses as supplying power in office buildings and in railroad locomotives.

AERONAUTICS

ALEXANDER KLEMIN, Sc.M.
Professor of Aeronautics, New York University

ONE of the most striking developments of the year in aeronautics has been the use of ethylene glycol in the cooling of aircraft engines. Since water boils at 212 degrees F., operating temperatures must be kept down to 180 degrees. With ethylene glycol an operating temperature of 300 degrees is possible. Therefore the radiator becomes much more effective and it is possible to cut its size to one third. This development will vastly improve the performance of large airplanes, to which liquid-cooled engines are especially applicable.

Airship engineers have much to congratulate themselves on in the round-the-world flight of the *Graf Zeppelin* in something over twenty-four days. It is significant that nationally known banking interests are discussing with airship and steamship companies the formation of transoceanic airship lines.

At the time of writing, tests of the Guggenheim Safe Aircraft Competition are proceeding. This competition has focused interest on aerodynamic safety, particularly with regard to slow landing and quick getaway.

While for the time being the aviation industry is a little burdened by overproduction, the future of commercial aviation remains as sound as ever.

RADIO

JOHN V. L. HOGAN
Radio Engineer and Inventor

THE growth of radio during 1929 has been not only in the improvement of technical processes and apparatus, but also in the organization and extension of its services and in the adaptation of radio principles to work in various other fields.

Public contact with radio is mainly through broadcast reception. Here the wide adoption of the A. C. type of screen-grid tube has provided receivers of greater selective ability and of exceptional sensitiveness; and it seems probable that newer developments will reduce the number of tubes required in order to obtain the most desirable results. There is also a definite trend toward the use of automatic and distant-operated station selecting devices, which further simplify the manipulation of home receiving sets.

Efficient transoceanic telephone service has been shown to be adequate for the relaying of international programs, and international radio telegraph service has been expanded. On the American continent there is growing a network of point-to-point telegraphic service by radio. Even television has now been shown to be capable of simpler and more dependable practical applications than many had thought feasible.

GEOGRAPHY

WILLIAM BOWIE
Chief, Division of Geodesy, U. S. Coast and Geodetic Survey

EXPLORATIONS have been in progress or initiated during the year along a number of different lines. Commander Richard Evelyn Byrd has been in the Antarctic, exploring the edges of the ice fields and, by airplane, the interior of Antarctica. Plans are under way for an exploration in the Arctic by the *Graf Zeppelin*, and it is expected that this expedition will be undertaken in 1930.

There has been greater activity in oceanography, an important branch of geography, than ever before. The National Academy of Science of the United States plans a report setting forth what has been accomplished and what are the outstanding problems to be solved. The Secretary of the Navy plans to have naval vessels of the United States, traveling between ports, determine the depth along the route by the sonic sounding method. Various oceanographic expeditions include the voyage of the nonmagnetic ship *Carnegie*, of the Carnegie Institution of Washington, and the gravity measurements by Dr. Vening Meinesz on the Dutch submarine in the East Indies.

President Hoover has announced his decision to initiate a program to complete the topographic mapping of the United States within a period of eighteen years.

There has been greater use of the airplane during the year in making preliminary surveys and maps over many inaccessible areas such as northern Canada, portions of Alaska, South America, and Africa. The airplane was used by Colonel Lindbergh in coöperation with the officials of the Carnegie Institution of Washington in searching for ruins of Mayan settlements in Yucatan and certain portions of Central America.

AUTOMOBILES

ALFRED REEVES
General Manager, National Automobile Chamber of Commerce

WHILE the motor production for the year just concluded was climbing well above the five-million mark, and sales abroad were in the neighborhood of one million vehicles, scientific advances were underwriting stability for the motor industry.

In short, we cannot divorce the study of this industry from its engineering aspects. There has never been in motor history a car at the Ford price which would travel at the Ford's speed and deliver the same pick-up. In the Ford and Whippet Four the public found engineering jobs of a quality never before available for the value. Similarly, Chevrolet for the first time offered a six-cylinder machine in its price class and equipped it with a body of unusual quality. There has been similar progress in all price ranges. The advent of the front-wheel-drive car, four-speed gear shifts, and various other items all serve to give the current cars a style aspect which is stimulating to public interest.

MEDICINE AND SURGERY

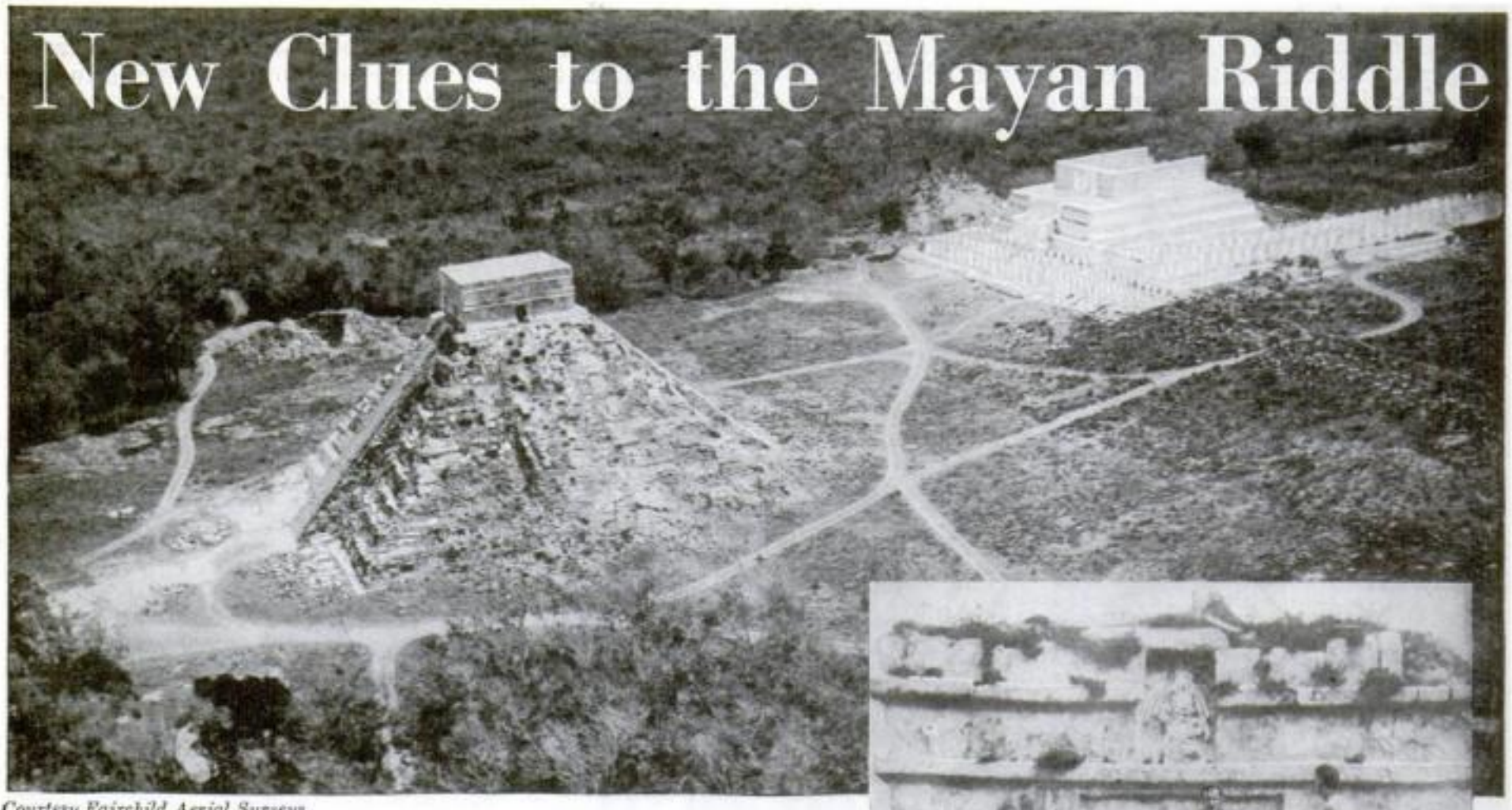
MORRIS FISHBEIN, M.D.
Editor, Journal American Medical Association

THE following subjects have been of exceeding interest during the year just completed.

The concentrated extract of vitamin D made by irradiating ergosterol and now prescribed and sold as viosterol is of the greatest importance as a preventive and cure of rickets, and for all other vitamin D effects in the body. Ultra-violet rays continue to be of interest, particularly a new quartz mercury vapor bulb developed by the General Electric Com-

(Continued on page 138)

New Clues to the Mayan Riddle



Courtesy Fairchild Aerial Surveys

Desolate grandeur that once was a great Mayan city on the Yucatan Peninsula, as viewed from the air by Colonel Lindbergh. He found ruins of three such cities.

A Strange Mystery of Prehistoric Americans Who Erected Cities and Deserted Them—No One Knows Why

By MICHEL MOK

Colonel and Mrs. Lindbergh, with Dr. Kidder of the Carnegie Institution, exploring Mayan ruins at Tulum, Mexico

SOARING over the tropical jungles of Central America a few weeks ago, the man who has become the living symbol of one of the latest phases in human progress looked down upon the crumbling remnants of the oldest American civilization.

In twenty-five hours of flying through the sultry air above Honduras, Guatemala, and Yucatan, Colonel Lindbergh, accompanied by Mrs. Lindbergh and scientists of the Carnegie Institution, of Washington, D. C., discovered ruined cities of the ancient Mayan Empire which could not have been reached by a ground expedition in less than five years.

Once more Lindbergh played a trail-blazer's part. In 1927, the famous aviator, by his superb flight over the Atlantic, linked two continents. On his recent brief but highly fruitful survey, made at the close of a journey with which he opened the West Indies-South America air-mail route, he established the initial aerial link between the present and the past.

For this was the first major archeological exploration ever undertaken from the air. The new method, in the opinion of Dr. Alfred V. Kidder, director of the archeological department of the Carnegie Institution, who served as chief observer on the trip, proved so successful that many similar expeditions are certain to follow.

From the cabin of his big amphibian, Colonel Lindbergh and his passengers saw and photographed slender columns of gleaming white rising from the dense jungle growth—ghostly reminders of an almost forgotten grandeur. They saw the decaying walls of once majestic temples, the remains of imposing pyramids, and in one case a group of twenty-five lofty buildings arranged about a central square. In all, they found the ruins of what centuries ago were four thriving, populous and beautiful cities. And of these, it is believed, three were never before seen by white men.

A carving of A.D. 503 depicting an astronomical congress of Mayan priests and scientists. On a similar stone was the oldest American date.

ABOUT a week prior to the start of the Lindbergh tour, Dr. José Reygadas, director of archeology for the Mexican government, announced the discovery of a great carved stone terrace amid the ruins of Chichen Itza, the holy city of the Mayas, in Yucatan. The terrace is faced with stone death's-heads indicating that it may be the long-sought tomb of some of the Mayan kings who, perhaps, were buried surrounded by a wealth of regalia and treasure, much in the manner of the ancient Egyptian pharaohs.

Further investigation of the Lindbergh discoveries and of the interior of the supposed royal sepulcher will, archeologists hope, shed new light upon the mystery of the Mayas, the highly civilized race which ruled Central America for centuries before enterprising Europeans, in quest of gold and power, discovered the "New" World.

Much of their history and evidence of their amazing culture have come to light in recent years, principally through the efforts of Dr. Herbert J. Spinden, curator of

ethnology of the Brooklyn Museum, and formerly connected with the Peabody Museum, Harvard University; Dr. Sylvanus G. Morley and other scientists of the Carnegie Institution; Thomas W. F. Gann, the British archeologist, and Gregory Mason, the American journalist-explorer. But the investigators are well aware that their present knowledge forms but a fraction of what remains unknown.

With records cut in imperishable stone, the Mayas suddenly make their first appearance upon the historical scene on August 6, 613 B.C. On that remote day—the oldest date in American history—they put into operation a workable and

AN important announcement, of unusual interest to every scientist and inventor in the United States, will appear in an early issue. Watch for it.

astonishingly accurate calendar system which has been the marvel of the scientific world since it was deciphered.

Why on August 6, 613 B.C.? Where were the Mayas on August 5? Had they lived, tilled the soil, developed their wonderful astronomy and admirable architecture, pursued their other arts and sciences on this continent before they carved that first inscription? If so, for how long? If not, whence did they come?

Nobody knows. Step by step, along trails of tangible remains, science has been able to trace the evolution of the Egyptians and other ancient peoples back to their earliest and crudest beginnings. But not so in the case of the Mayas. So far as any concrete evidence is concerned, they might as well have dropped down from Mars or some other planet on the morning of that sixth day of August 2,542 years ago.

Toward the close of the first century of the Christian era, when the decline of Rome had begun, the first Mayan Empire began a cultural development that was to culminate in a period of brilliant achievement from about A.D. 300 to 600 But then, at the height of its power and glory, the empire suddenly collapsed. Within approximately fifty years, the magnificent cities with their monumental temples, sculptured and jeweled palaces, astronomical observatories and, probably, thousands of dwellings grouped about the edifices of worship and public business, were abandoned. Soon they were covered by the tropical forest as completely as though the earth itself had opened up and swallowed them.

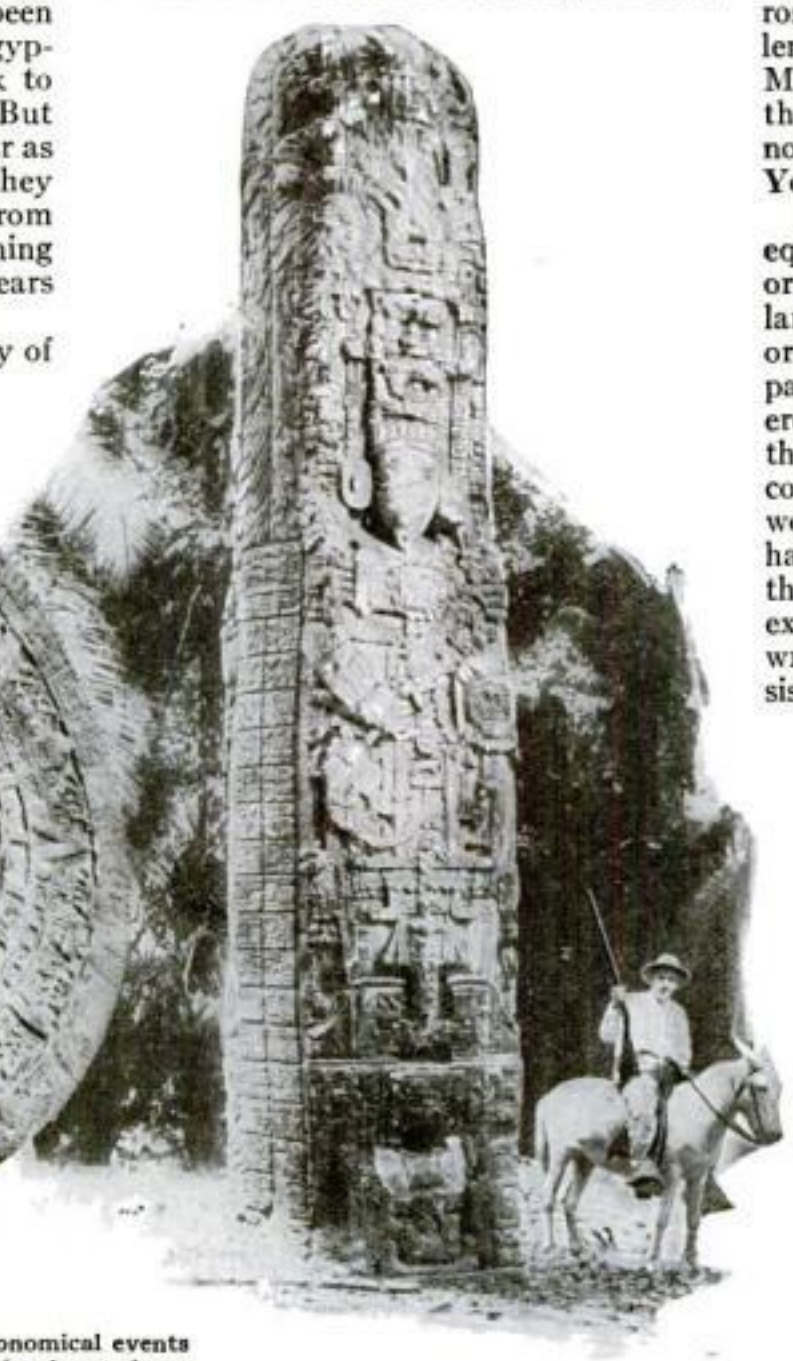
A striking specimen of an altar stone from an ancient Mayan temple, showing method of inscribing hieroglyphs and dates.

What happened? What catastrophe befell this race, so sturdy in body, so keen in mind? Did it fall victim to a suicidal civil war? Did its food supply suddenly give out? Or was it decimated by some devastating epidemic? Experts say yellow fever probably had much to do with the dramatic decline. But nobody really knows.

After three lean centuries, during which the Mayas surviving the collapse settled in western Yucatan, there came a period of renaissance—the Second Empire. But, though they succeeded once more in achieving a measure of prosperity and of artistic and scientific accomplishment, the glory and splendor of the first great period were never quite recaptured. And when the Spaniards came in 1519, the old grandeur was a mere memory.

So much, in brief, for the mysterious rise and fall of the Mayas. Should the Lindbergh finds and the presumed "tomb of the kings" at Chichen Itza yield the answer to the riddle of their origin, another problem might also be solved—the question of how they came by their remarkable cultural attainments.

A "wheel" calendar of the early Aztecs, who learned to count time from the ancient Mayas.



The Mayas inscribed dates and astronomical events on lofty monuments, one of which is shown here.

THE Mayas were the Greeks of the West. As architects, they were the inventors of the skyscraper, for their temples and other structures, though usually consisting of not more than two or three and, in rare cases, five stories, rose to a height of 200 feet—the equivalent of eighteen-story modern buildings. Moreover, they were the originators of the "step-back" or "set-back" principle now so conspicuous in the design of New York business towers.

Although their architecture did not equal that of the Egyptians, the Greeks, or the Romans, yet their edifices have largely resisted the ravage of 1,500 years or more in a destructive climate. In painting and sculpture they are considered the superiors of the Egyptians—their weirdly beautiful feathered-serpent column, for example, is unique in the world of art. Their elevated stone roads have proved better time-defiers than those of the Romans. And while their extraordinary system of hieroglyphic writing—a sort of pictorial shorthand consisting of abbreviated pictures of the objects to be described—was involved and cumbersome in comparison with the Roman and Greek alphabets, at least it was as serviceable as that of the Egyptians.

At the zenith of its power, the Mayan Empire was a thriving nation of some 14,000,000 prosperous and comparatively enlightened people of whom, by the way, just a few thousand poor and ignorant Indians are the present descendants. It took much beside lovely buildings, skillful carvings, and pretty pictures to maintain that great body of men, women, and children, almost half again as numerous as the population of New York State today. They were thorough-going farmers, efficient busi- (Continued on page 126)

Photograph Secrets of Living Cells

By

HUGO SCHWARTZCHILD

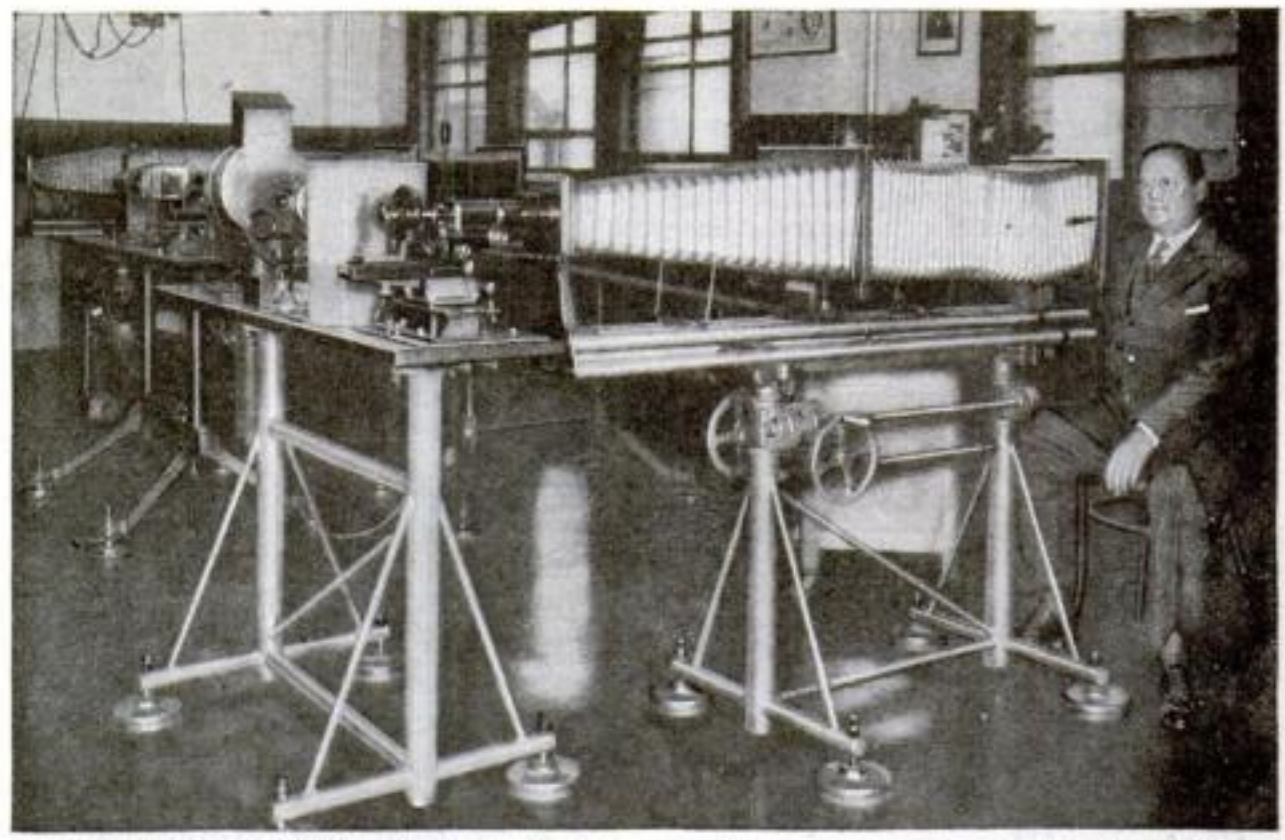
PHOTOGRAPHS of the complicated architecture and machinery inside a living cancer cell or other similar unit of life have been made by the remarkable ultra-violet ray microscope, most powerful magnifying instrument in the world. This achievement is the work of Francis F. Lucas, internationally-known metallurgist of the Bell Telephone Laboratories, New York City.

His apparatus is said to magnify an object more than 6,000 diameters; and the ultra-violet light, used in place of visible rays, gives a sharper image and clearer detail for microphotography. The instrument has a resolving power of 1–150,000th of an inch; that is, it will separate two lines that are only that distance apart. It has been used in studying various alloys and in examining the photographic emulsions on sound picture films as well as in the important work of cancer research.

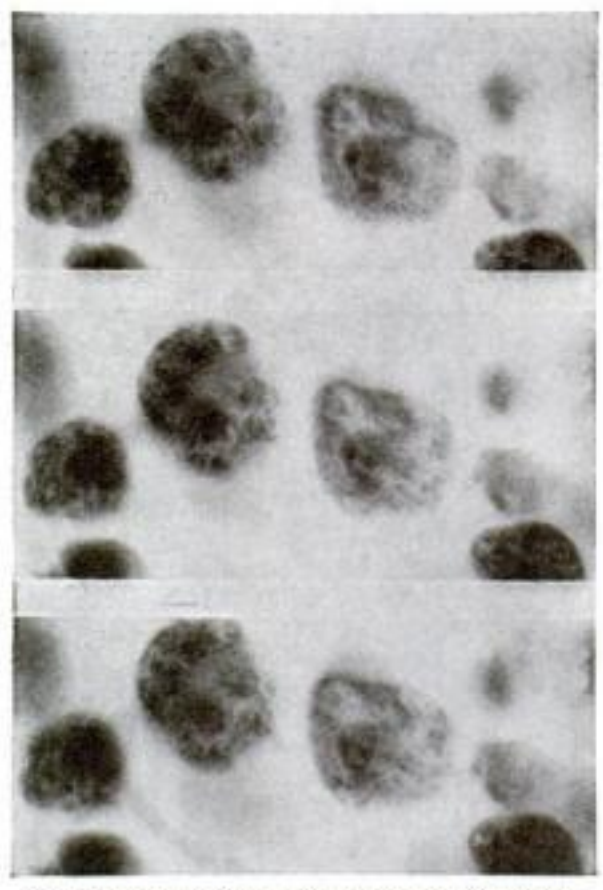
Biologists have long been sure that the inside of a living cell does not consist merely of the featureless, living jelly called protoplasm, but that many other structures are present. What they have been anxious to know is the nature of these mechanical structures, how they work and what are the duties of each.

To some extent these structures can be seen in ordinary microscopes, especially if the living cells are killed, dyed with suitable chemicals, and then cut into extremely thin slices by an exceedingly sharp razor. But such methods have the fundamental disadvantage that they kill the object which is being studied. Biologists have always realized that perhaps the things seen under these circumstances have been created by the cell's death and embalming, not by the life of the cell before it died.

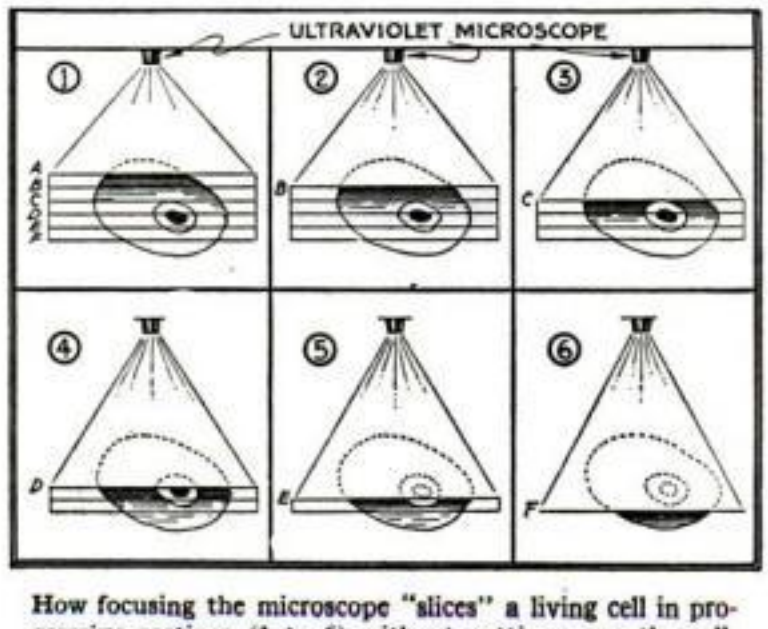
With the new method of the ultra-violet ray microscope cells can be examined, photographed, kept a while, and photographed again without any fatal damage to the cell's life. It is possible to make slice photographs, the separate slices being less than one hundred thousandth of an inch apart, without cutting open the cell at all. The rays that operate the microscope are merely focused on the desired level inside the cell and the picture is snapped. The rest of the cell, both above and below that level, disappears altogether, like the out-of-focus background of an ordinary photograph. The fact that the ultra-violet rays by which the new microscope works are so much shorter in wave length than ordinary light rays makes it possible, too, to photograph tiny objects inside the cell much smaller than those which visible light rays would detect.



Francis F. Lucas with his ultra-violet microscope, special lamp, and camera. Invisible ultra-violet rays throw a magnified image of a living cell on a photographic plate in front of where he sits.



Cancer cell photos, showing internal structure.



How focusing the microscope "slices" a living cell in progressive sections (1 to 6) without cutting open the cell.

This use of these invisible ultra-violet rays makes it necessary, however, to use photographs altogether instead of using the eye. Lucas cannot even see to focus the lenses of his instrument on the desired level. That operation must be accomplished mechanically, by setting screws and levers at the proper points. The lenses must be cut from crystals such as quartz or fluorite, not made of glass, for glass is opaque to the ultra-violet rays which must be used. Ordinary lamps will not operate the microscope, for it is too weak in the ultra-violet radiation. Instead, a special form of electric arc lamp must be used.

PERHAPS the most promising application of the new method is the study of cancer cells. One theory of why these cells go wild in the body and keep on growing indefinitely until they form a tumor or even until they press against other cells and cause death, is that something has gone wrong with the internal cell machinery that controls growth, probably closely related to the machinery that controls heredity. If this machinery can be seen in action, which Lucas' method now is expected to make possible, perhaps new clues to the cause of cancer can be discovered.

Already good photographs of living cancer cells have been made, disclosing, slice by slice through the cell, visible differences in the living machinery. These are now being studied by cancer experts. Photographs have been made, also, of the cells of living brain tissue, also known to contain complicated internal machinery probably important in the proper action of nerves and of the brain. In collaboration with Dr. Mary B. Stark, expert on embryology and histology at the Flower Hospital in New York City, Lucas has made these same slice photographs of living sperm cells of a grasshopper dividing to form new sperm cells, the act believed to be at the basis of heredity.

Panama Dam to Aid Canal Traffic

TRAFFIC jams at the Panama Canal would be averted by a $12,000,000 dam proposed by Governor Harry Burgess, of the Canal Zone. The proposal has just been approved by Secretary of War James W. Good, and Congress will be asked shortly for $2,000,000 to begin construction.

The artist presents here his conception of the plan and also shows the physical nature of the isthmus that makes it necessary. Water from artificial lakes surges into locks at Miraflores and Gatun to lift vessels over the hump of the isthmus from one ocean to the other. But, four months out of twelve, water shortage impedes the rapidly growing traffic through the canal. Additional locks at each end of the canal have been suggested to double its capacity. But more water will be needed.

Governor Burgess proposes a 170-foot-high dam at Alhajuela, which, by impounding waters of the Chagres River during the rainy season, would supply storage water for all-year operation. The dam would form a reservoir of twenty-two square miles, storing 22,000,000,000 cubic feet of water and flooding scores of native villages. A hydroelectric plant would be another feature of the project.

Relief map of the Panama Canal region, and plans for the proposed storage dam at Alhajuela to increase the capacity of the Canal. Drawn especially for POPULAR SCIENCE MONTHLY by B. G. Seielstad.

Home Movies—The 1930 Family Album

How Improved Cameras and Film Have Made Amateur Producers of 150,000 Americans

By ROBERT E. MARTIN

With a small amateur movie camera incidents of vacation or travel can be recorded permanently, later to be revitalized on the screen.

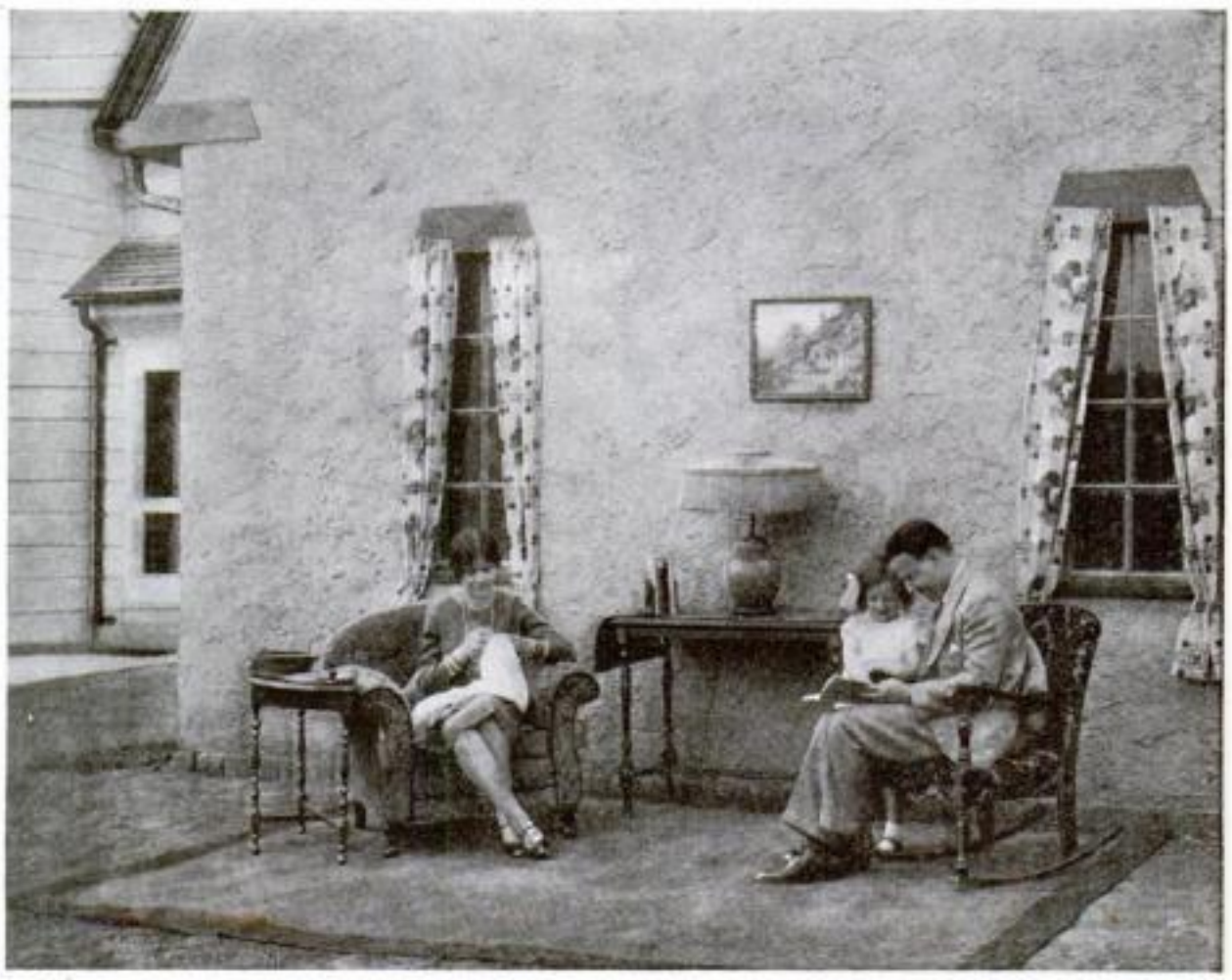
THE other day, a home movie enthusiast in California began making a unique "Jack-and-the-beanstalk" diary of his little daughter. Once a month, he will "shoot" a small strip of film of her standing in the same place. He plans to continue this until she is grown. When the films are then patched together and run through the projection machine, they will show a baby springing up to womanhood with the speed of the beanstalk in the fairy tale. Other home movie fans are planning similar records, made in the manner of the familiar screen feature which shows a flower budding and blossoming before the eyes of the audience.

Nearly 150,000 persons in the United States alone, it is estimated, have taken up the hobby of catching action pictures of their families, relatives, pets, and friends. Remembrances of happy times are being preserved on the family silver-screen. In place of the red plush photograph album, which rested on parlor tables a generation ago, there is the modern "action album"—the home movie reel. The home movie camera is opening up whole new fields of entertainment. This does not mean, of course, that the "still" camera is going out of existence. The latter always will occupy its own particular niche as the telegraph now does in spite of the revolution in communication caused by the telephone.

Thirty-three years ago, there was only one moving picture camera in the world. It was Edison's original invention. For more than twenty years, the camera that records movement was almost exclusively used for professional purposes. It has provided entertainment for audiences which grew from a dozen people sitting on folding chairs in improvised rooms above stores, to millions filling the auditoriums of immense, palace-like theaters. Only within the last few years, however, has a light, comparatively cheap camera given amateurs the opportunity to take their own motion pictures for the fun of it. In the fall of 1924, the first amateur cinema cameras made their appearance in America.

There is one point of difference between the amateur movie camera and the ordinary still camera. If a man knows nothing about photography, he is likely to get as good pictures from a still camera costing from two to five dollars as he is from one that cost seventy-five dollars, simply because the extra adjustments on the better outfits are useless unless one knows what they are for and how to use them. This is not true with the amateur movie camera. The beginner will get excellent results with the most expensive camera obtainable, and if he does not know how to handle long focus lenses and so on, he can leave these for later purchase after considerable picture-taking experience is gained.

THOSE who have taken up the new sport include noted people of many lands. Both Mrs. Herbert Hoover and Mrs. Calvin Coolidge are enthusiastic "shooters" of home movies. Madame Galli-Curci, the opera singer; Governor John Trumbull, of Connecticut; Princess Ileana, of Roumania; and Sir Victor Sassoon, of England, are all expert in handling the small cameras. The familiar joke about sailors on leave spending their time boat-riding seems to have a parallel in Hollywood, where many of those engaged in professional pictures make amateur movies on the side for fun. Clara Bow, Lon Chaney, and Fred Niblo, the director, are among the best-known devotees of the amateur cinema. Next to the United States, England, Canada, and Australia seem to have the largest quota of fans. But other countries have their enthusiasts as well. Even in far-off Siam,



The staging of scenarios by members of the family is one of the interesting developments of home movies. Above is one example of how an interior setting may be arranged outside of the house.

His Royal Highness, King Prajadhipok, spends his leisure time adding to his library of home movie reels.

TAKING sixteen pictures a second on incombustible film, half the width of that in professional use, the modern five-pound camera exposes 100 feet of film without refilling. Four times that amount, 400 feet, is accommodated by the home projection machines which throw the pictures on the screen. The film runs through these machines at the rate of ten feet every twenty-four seconds. Thus a 400-foot reel will provide entertainment for more than fifteen minutes. Libraries of standard films, ranging from travel pictures to well-known photoplays, are also available for use with the home movie projector.

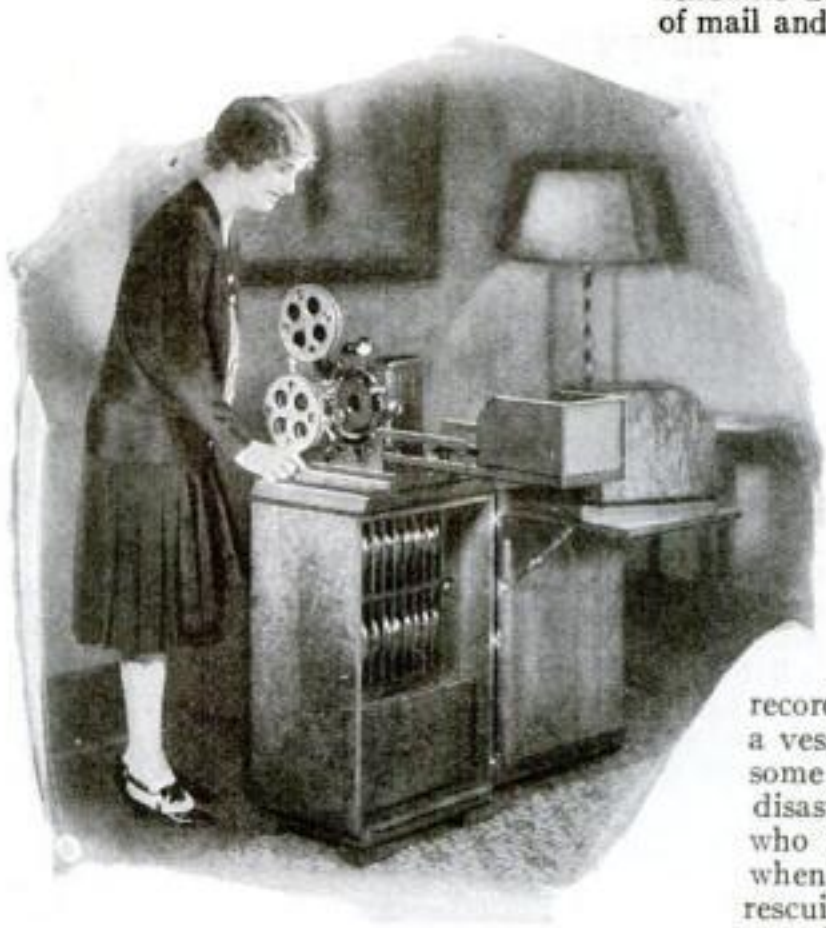
To make personal movies, all that is needed is a camera, a projector, and a film splicer. A special screen is often used but a bare wall may be substituted. Men whose business it is to develop home movie films find that the subjects of most reels are children. Pets come next, with sports ranking third. Probably most cameras at present are purchased to record in permanent form the ways of small children. Later, when the youngsters are grown, the parents, at a touch of an electric button, can see them romp across the screen just as they did years before.

A NEW accessory that aids in obtaining natural pictures of children at play is a turret lens which allows the use of any one of three different focal length lenses, permitting the photographer to make close-ups of subjects fifty or a hundred feet away. With a camera so equipped, pictures of children may be taken from a distance without their realizing they are being photographed. Another device (P.S.M., June '29, p. 68), permits a "still" picture to be made from any negative in a reel, thus preserving a fleeting, characteristic expression, which an ordinary camera would miss. A vest-pocket tripod, which telescopes to the length of a lead pencil, is another new aid in obtaining good pictures. However, a tripod is not ordinarily needed, as most reels are obtained by aiming the camera just as in taking an ordinary snapshot.

The range of usefulness for amateur movie photography seems almost unlimited. For example, Raymond L. Ditmars, curator of reptiles at the New York Zoological Park, photographs reels of his crawling charges and has made a number of films of snakes in their natural surroundings. Some of these proved so good that they have been distributed to zoology classes of neighboring schools.

In the middle west, not long ago, during a hot fight over a proposed civic improvement, one enthusiast drove to other towns, took reels of similar improvements in operation, and won the voters to the proposed plan. Another unique use of a home movie outfit was made last spring at a reunion of alumni at an Eastern university. Reels showing "old grads" on the campus were sent out to distant alumni who had been unable to attend. When they ran them through their projectors, they saw old classmates smile and wave a greeting, just as though they, themselves, were walking on the campus. College officials found that the plan aided in cementing the alumni together and hereafter the home movie reels may be a regular feature of the reunions.

CAN 100 miles an hour be made a safe, practicable motor car speed? Eminent automobile experts discuss this question in a forthcoming issue.



One of the new cabinet projectors. The picture may be viewed on a small screen without darkening the room.

By a new method, four times the usual number of pictures can be taken on standard-sized film. Arrows indicate movement of the film across the camera lens. One box of film becomes the equivalent of four, and the small reel will show as much picture as the large one holding four times the amount of film.

Probably the strangest use of a home movie outfit was that by which ancient armor was "brought to life" in the Metropolitan Museum of Art, in New York City, not long ago. An amateur movie fan suggested to those in charge of the armor room that greater interest could be aroused if visitors were shown how the armor was actually used. So several attendants donned the casques and coats of mail and then staged impromptu tournaments beside one of the parapets in Central Park. The reels taken at the time were later projected on a small screen for Museum visitors.

WITH more than 150,000 amateurs scattered in all parts of the world, additions to the picture record of current events are constantly being made. Already, amateurs, with their little machines, are said to have twice "scooped" the enterprising professional news-reel camera men in recording important events. When a vessel sank off the Florida coast some time ago, the only film of the disaster was made by an amateur who had taken along his camera when he booked passage on the rescuing ship. Equally spectacular was the scoop of Lucille K. Hughes of Detroit, Mich. When Henry Ford made his first airplane flight, she made the only movie of it. On the spur of the moment, Ford decided to go up with Col. Charles A. Lindbergh. When he stepped suddenly into the plane, there wasn't a news reel photographer in sight, and the little home movie camera recorded the only action picture taken of the event.

HOWEVER, the little sixteen-millimeter film of such cameras is too small for projection in regular theaters and when it is "blown up" to standard size, the images often blur. But, thrown upon the home screen, as they are intended to be, the images are as clear as life. The truth of this was demonstrated in an odd manner a few months ago. A valuable camera was stolen from a parked automobile in New York City. The secondhand dealer to whom the thief tried to sell the camera became suspicious. When he began asking questions, the thief hurried away and the dealer turned the camera over to the police. The film was developed and run through a projection machine, while detectives looked on. One recognized a face on the screen as that of the son of a prominent judge. Because of the lifelikeness of the pictures the camera was traced to its owner.

Knute Rockne, Notre Dame's famous football coach, is numbered among the amateur cinema fans. For the last two years he has taken pictures of different players in action. Then the pictures have been run

(Continued on page 130)

How I Got into the Air

By
ASSEN
JORDANOFF

This is the first of a series of articles in which a veteran pilot tells the story of his sixteen years of flying. Readers of this magazine will remember Assen Jordanoff as one of the instructors who taught Larry Brent to fly. As designer, test pilot, barnstormer, war bird, air mail flyer, and instructor, he has seen aviation from every angle. His is an absorbing story of adventure, a lively record of personal experiences revealing how a master of aircraft has solved the problems every flyer must face.

MY FIRST flight was made on a barn door.

That was in 1909. I was a little fellow, twelve years old. Bleriot, my great hero, had just flown the English Channel. From newspaper accounts, I got the impression that the wings of his monoplane were flat and made out of wood—the same as a barn door. As I remember the adventure, I made a swift toboggan down the slanting roof of a shed and hit the ground with a mighty thump.

I had already jumped off a telephone pole with my father's best silk umbrella. I had built a monster kite that jerked me across a field and bumped my nose against a board fence. I had cut out five-foot cardboard wings, strapped them to my arms, and jumped off a window sill. I was so sure I would soar away that I didn't pay any attention to what was below the window. In a second, I found out. It was a cement sidewalk.

A few months after the Wrights first flew in 1903, when I was seven, I read an article in a boy's magazine. It told all about balloons. It described a wonderful dirigible with which Santos-Dumont had navigated the clouds in France. I used to climb up on the roof of our house in Sofia, Bulgaria, and, sitting on the ridge, read that article over and over. I read it fifty times if I read it once. I determined to fly.

That was twenty-five years ago. Since then, I have designed and built planes. I have piloted bombing and pursuit ships. I have flown the air mail, instructed students, barnstormed in small towns. I have plunged out of the sky with a flaming motor. I have missed mountain crags by inches in the fog. I have had a gasoline tank explode under my seat—6,000 feet in the air. Yet, today, flying holds me as strongly as ever.

WHEN the cardboard wings failed me, I decided to begin at the beginning and make models. They were turned out about one a day for months. I threw them off the roof. Neighbor boys, whom I had deserted for the clouds, used to catch them and run off. I remember one evening I was taking one of my models to a hillside on the edge of town. Four or five of the boys jumped from behind a building as I passed by, broke my model, and blacked my eye.

In 1910, a Russian aviator came to the country. He gave exhibitions in an early Farman "box-kite" biplane. I hung around the field night and day. I made sketches of every detail of the machine. When he left in 1911, I began to construct a little plane of my own. It was made of bamboo, held together by a vast spider's web of piano wires. I sacrificed my bicycle to put wheels under it. They were placed too far back. When I climbed into the seat, the machine flopped down on its nose, tossed me on the ground, and broke in a dozen places.

The next year, I really got into the air. I built a glider like the one Chanute made in America. It was the first machine built in Bulgaria to fly. Two years later, I constructed the first successful airplane made in my country. The glider carried me down hillsides a few feet above the ground and once, when several men pulled it kitewise into the wind, it soared up to fifty feet.

A maker of future pilots—Assen Jordanoff as he appears today, an instructor in the Curtiss Flying School at Valley Stream, Long Island, N. Y. He is standing beside a Curtiss Robin, one of the latest types of cross-country monoplane.

That summer, my family visited France and I got a chance to see the old Bleriot school at Etampes. Bleriot, himself, was there, in a pair of greasy overalls, testing a new Gnome-motored monoplane. I also saw Farman, Beaumont, Vidart, Vedrines, and other great pilots of the early days. I was so excited that I could hardly sleep. I begged my father to let me go up. Just before we returned home, I had my wish. I made a ten-minute flight with one of the Bleriot instructors. I cannot recall his name, but I remember he was fat and jolly. When we landed, I told him I hoped to be an instructor myself someday. He laughed and patted my shoulder. I wanted to go to the flying school then and there. But I was too young.

THE other day, I had an adventure which recalled those early times to my mind. It also suggested that thousands of Americans, under sixteen, want to learn to fly as badly as I did, but are not old enough to enter a flying school. Perhaps I can make some helpful suggestions.

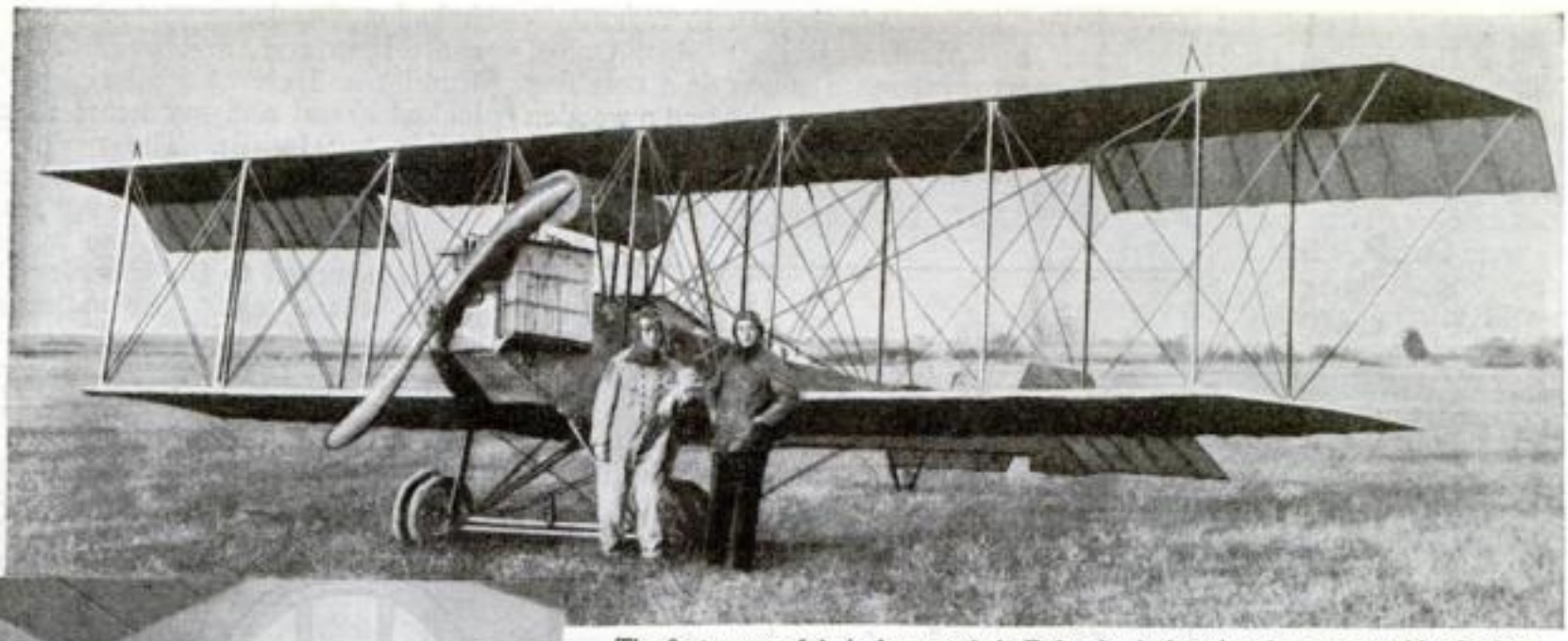
I was ferrying a new ship from St. Louis to Long Island. Near Schultzville, Pa., the gas ran low and I set her down in a field. A dozen boys appeared on the run. They watched me for a few minutes and then one asked:

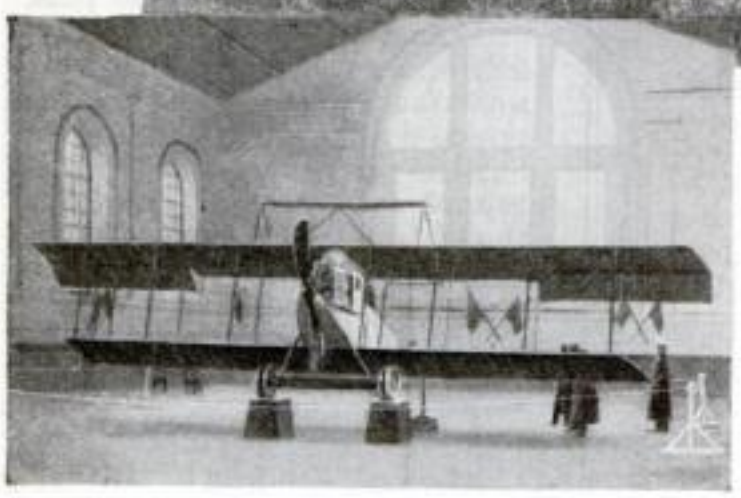
"Didn't you teach Larry Brent to fly?" They had read the series "I Am Learning to Be a Flyer" in POPULAR SCIENCE MONTHLY. They recognized me from the pictures.

"I gave him his first lessons," I told them.

Then they felt they knew me. They helped get gasoline and I gave several a ride. They asked a thousand questions. They were still asking them when I gave her the gun and waved goodbye. Since then, two of them, Richard Mathews and Russel Thorpe, have written several letters. They want to know, as many others want to know, what they can do at home to prepare for flying school.

There are several things that can be done. For instance, at home you can develop the two necessary qualities of every aviator, a sense of balance and a judgment of distance. All games like tennis,





The first successful airplane made in Bulgaria, designed and constructed by Jordanoff (at right) in 1914. The landing gear axle was a piece of water pipe. The photo at the left shows the historic plane on exhibition in King Ferdinand's palace.

golf, baseball, and billiards train the eye to judge distances accurately. Rifle and pistol practice and hunting help, too. It has been found that a crack shot usually makes a crack pilot. He has trained his eyes and his nerves.

For the development of your sense of balance, there is nothing better than horseback riding. Cavalrymen learn to fly in fewer hours than men from almost any other branch of the Army. Sailors, on the other hand, are usually slow in learning. They are used to the wide spaces and slow movements of the sea. They begin by making their motions too deliberate. When they learn, they make fine flyers because they are fearless.

IF YOU want to test your natural sense of balance you can do it by a simple experiment. Close your eyes and stand on one leg. If you can keep from swaying for fifteen seconds, your sense of balance is good enough for piloting a plane.

Automobile driving, naturally, is excellent training for flying. Taxi drivers pick up piloting in short order. Their work has trained them in quick thinking and perfect coordination of mind and muscle. If I were asked to choose the greatest pilot I have seen in sixteen years of flying, I would name the early French flyer, Jules Vedrines. He combined, in a superior degree, alertness and fearlessness. He was once a Paris taxi driver.

Another thing you can do at home is to learn about motors and mechanics. You can familiarize yourself with the parts of an airplane, the theory of flight, and the terms used around an air field. This helps you know what it is all about when you arrive at a school. It saves precious time. Also, get into athletics as much as possible. An inactive person, or a desk worker, almost always requires more hours to learn to fly than a sportsman or a trained athlete.

In February, 1912, the Balkan War broke. Bulgaria went to battle against Turkey and I joined the first flying squadron ever to engage in active warfare. Although I was only fifteen, the fact that I had flown a glider let me in. Those original war birds began with one Bleriot plane, ten mechanics, and three graduate pilots who had soloed about forty-five minutes. Later on we collected between thirty and forty flying coffins from all over Europe. Before a pilot took off, we always wet our fingers and held them up to discover the direction of the breeze. I was in charge of making bombs. They were ordinary tin cans stuffed with explosives. They made an awful noise, but did little damage. As observer, I flew over the lines a dozen times. Once, I came within a sooty spark plug of being one of the two first flying prisoners of all history.

A Russian pilot, named Kostin, had joined our forces. We took off from the Mustapha Pasha field, near Adrianople, in a Farman biplane. Our seats were on a sort of ladder stuck out in front of the lower wing and the Gnome motor at the rear whirled around with the propeller as it drove the machine. Four miles out, the motor suddenly began to miss. Kostin landed on a mountain side and sent me back for a new set of plugs. While I was gone, he got the motor going and decided to fly over the lines alone. That was the last seen or heard of him until the end of the war. Then he was found in a Turkish prison. He had been sentenced to death, but the sentence was commuted by a Turkish general whose own life had been spared by a Russian commander in a previous war with that country.

Jordanoff in the cockpit of a light pursuit plane, serving as a war pilot with the Bulgarian forces on the Saloniki front.

HOSTILITIES lasted eleven months. Ten months passed without my being made a pilot. I got desperate. One noon when a single soldier was guarding all the machines, I got the motor of a Bleriot going, climbed aboard, and ran away. After skimming the tops of the daisies for the length of the field, I came down with a jolt. By that time, the whole squadron was on the field and the Commander came running up, red-faced and out of breath. But the next week he assigned a Swiss pilot to teach me to fly. I was just ready to go over the lines when the war ended. I thought the Turks heard I was coming and gave up.

After the war, I went back to school. But I used to get up before dawn to go out to the flying field to practice before classes began. I would lose my hat and my books. I would come to school with grease smeared on my nose and sometimes I would forget to come at all. But I was learning to fly when learning is easiest.

Experience with more than 200 students, ranging in age from sixteen to sixty, has taught me that the younger a student is when he begins to fly, the better pilot he is likely to become. For young people, piloting be omes instinctive. Few beyond forty-five become good pilots. Major General Mason Patrick, former Chief of the Army Air Service, is a striking exception. When he held a stick for the first time, he was sixty-three. Yet he made a fine pilot.

An ideal student has three qualities. He should be young. He should be athletic. He should be good-natured; that is, able to take

his breaks with a smile. I pick out students who will make skillful pilots by watching their eyes. They are alert. Dreamy-eyed, sluggish pupils are a second too late in their movements in the air. And in a jam, a second equals a lifetime.

An absent-minded person, or a person with a "one-track" mind, should keep away from flying. I was once up with a student who got concentrating on keeping the wings parallel with the horizon.

He didn't notice the nose of the ship was pointing down in a steep glide. We dropped more than a thousand feet. If I hadn't taken over the controls, he would have hit the ground, perfectly satisfied with his piloting because the wings were level.

IN SPARE hours while I was going to flying school, I built a tractor biplane of my own design. It was finished in 1914. I remember the only thing I could get for the axle of the landing gear was a piece of water pipe. It bent down in the middle as soon as the weight of the machine rested on the wheels at both ends. So I put a heavy rubber cord from the bottom of the fuselage to the center of the pipe. It acted as a shock absorber when the wheels touched the ground in landing. To the surprise of everyone, the plane flew like a gull. It was the first built in Bulgaria and King Ferdinand exhibited it at his palace.

Designing that ship helped me to fly. It gave me a knowledge of the laws of aerodynamics that enables me to judge when my ship is getting into a dangerous position in the air. Pilots who know nothing about the technical side of aviation often imagine their planes are getting into danger when they are perfectly safe. They fly under a constant strain. The more you know about what makes the wheels go around in flying, the easier your mind is in the air.

That brings up my philosophy about crashes. In the air I never think of crashing. I learn just how far my machine can go and just how far I can go; what our limitations are. Then I concentrate on keeping within those limits. It keeps my mind set upon the part of flying I can control and prevents "nerves."

When the World War began, Bulgaria joined the Central Powers. Like other boys in all the warring countries, I enlisted. For two years, I flew on the Saloniki front, piloting D. F. W.'s, Fokkers, and Albatross pursuit ships. One of my narrowest squeaks was on a bombing flight with an observer who had a wooden leg.

We crossed the lines in an Albatross at 12,000 feet. It was so bumpy the instruments jiggled until they were practically useless. Below, little smoke mushrooms showed where antiaircraft guns were trying to reach us. I kept watching a cloud overhead. British war birds might drop out any second.

Suddenly an air pocket plunged us down a hundred feet. There was a grind and crash. The motor howled. The ship staggered all over the sky. I thought an enemy plane had shot off the tail. I jerked my head around, looked at the rear control surfaces, and waggled the stick. Rudder and elevator all right. Then I looked ahead and my heart zoomed up beside my tonsils. The motor, a 220-horsepower Benz, was hanging half out of the fuselage, flopping from side to side. I cut the switch and shouted to the observer to let go the bombs. The motor stopped swinging. I headed back over the lines. The artillery below went mad.

Any second I expected to see the wings break off, for one of the main bracing cables had been torn loose. Between us and our home field was a 7,000-foot mountain. We just missed the peak and came down in an uncut hayfield on the other slope. The ship somersaulted and left us hanging upside down by our safety belts. Soldiers with drawn revolvers ran toward us ready to shoot. They thought we were enemies. Afterwards, I discovered that a piece of antiaircraft shrapnel had torn off half the propeller and the uneven jerk of the other half had torn the motor loose. Our only injury was a broken hinge on the observer's wooden leg!

AFTER the war, flying in Bulgaria was dead. By the terms of the Armistice, all the planes were heaped together in great piles and burned. One ship, an ancient D. F. W., was saved for me to carry government air mail between Sofia and the Black Sea. Its laminated wood fuselage was soaked full of oil. One backfire from the motor and we would have come down a flaming torch. At the end of my second run, I left the old tinder box tied down in a field near Varna, the Black Sea port. That night a hurricane struck the town. The next morning my plane was gone. I asked a farmer:

"Have you seen my plane?"

"Yes."

"Where is it?"

"Behind that house over there," pointing to a dwelling a mile away.

"Who took it over there?"

"The hurricane did."

All I salvaged from the wreck was the compass. That decided me. I would go to America where flying began and where flying jobs must be easy to obtain. I landed in August, 1921. Immediately I discovered my mistake. Aviation was at a standstill. Pilots were barnstorming and hopping passengers to make a bare living. Public interest was nil. I had brought all my money, hoping to get backing to fly the Atlantic. While I waited for backers that didn't appear, I put on a brave front, living at the best hotels and spending money like a Sultan. By the week before Christmas my pockets were empty. Six thousand miles away from home, I was without money, without friends, (Continued on page 136)

What Should a Pilot Do, If —

His motor catches fire?
He loses a landing wheel?
A hole is torn in his wing?
He sees he is going to crash?
He is forced down over a city?

From expert knowledge gained by his own thrilling experiences, Assen Jordanoff answers these and many other questions on flying in his second article next month:

"MEETING the UNEXPECTED"

A war picture of Jordanoff, Bulgarian ace, with a captured French Nieuport fighting plane. Left: One of Jordanoff's narrowest squeaks—the D.F.W. that somersaulted as it landed after a bombing flight.

The enormous pneumatic tube plant in the basement of the New York Life Insurance building. With 139 tube lines serving executive offices in the building, it does the work of 300 messenger boys. The messages travel at race horse speed.

Pneumatic Stevedores Heave Coal and Wheat

By ALDEN P. ARMAGNAC

In the office—loading a message container for dispatch by tube.

A SKYSCRAPER now rising in the heart of New York's financial district will offer its occupants a novel type of delivery service. Each broker with offices in the building will be assigned a cage in the basement. Stocks, bonds, and checks to be delivered to his office will be brought to that cage. They will be placed in a container and inserted in a pneumatic tube. A puff of air, and a few seconds later they will emerge in the office many stories above. There will be no messengers to crowd the elevators of the building's upper stories—elevators which are necessarily small because of the limitations of the modern style of set-back architecture.

Messenger boys are going out of style. Pneumatic tubes are taking their places. Great office buildings are installing pneumatic systems, not only for delivery service but for interoffice communication on a grand scale. No longer is it necessary to rely upon a boy's uncertain footsteps to deliver an important message from one executive to another. A carrier shot by air gets it there at once.

In the mechanization of modern business, pneumatic tubes have achieved these and many other wonders. They have made it possible to blow coal, wood pulp, even lumber through pipes. Mail and telegrams fly regularly to their destinations via underground "airways." The mechanical messengers have become of key importance in industry and commerce.

Unloading wheat from an American vessel at Naples, Italy. The grain is sucked through heavy rubber pneumatic tubes.

Pneumatic dispatch is speedy. It is economical. But above all it is simple, and the absence of complicated machinery to get out of order is one important reason for its wide use. Blow through a pipe containing loose powder, and the powder goes out at the other end. In practice, things heavier than powder—as heavy as lead buckshot, for example—can be blown through a tube. This is the scheme used for industrial conveying. And it is a simple matter to substitute for loose materials a bulletlike carrier with a leather or felt ring just large enough to make a close fit in the smooth tube without sticking or dragging. This is the system that office buildings are installing. The familiar change tubes in department stores, and scores of other kinds of pneumatic installations, work on the same principle.

INGENIOUS systems of valves admit compressed air and control the movement of carriers through the tube. Sometimes suction is used, instead of compressed air. It pulls the loose material or carriers through instead of pushing them, as a vacuum cleaner sucks up dirt through its hose. Impelled by pressure or

vacuum, the carriers reach high speeds—twenty or thirty miles an hour or more. Some of the larger ones are oval-shaped, and have room for sheaves of typewritten documents or for dictaphone records.

IT IS this type which has recently displaced human messengers in skyscrapers of New York, Boston, and other cities. The ultramodern installation of the New York Life Insurance Building does the work of 300 messenger boys. A message from a fourteenth-floor office of this building can go through the "pneumatic terminal" in the basement and arrive at another fourteenth-floor office in thirty seconds.

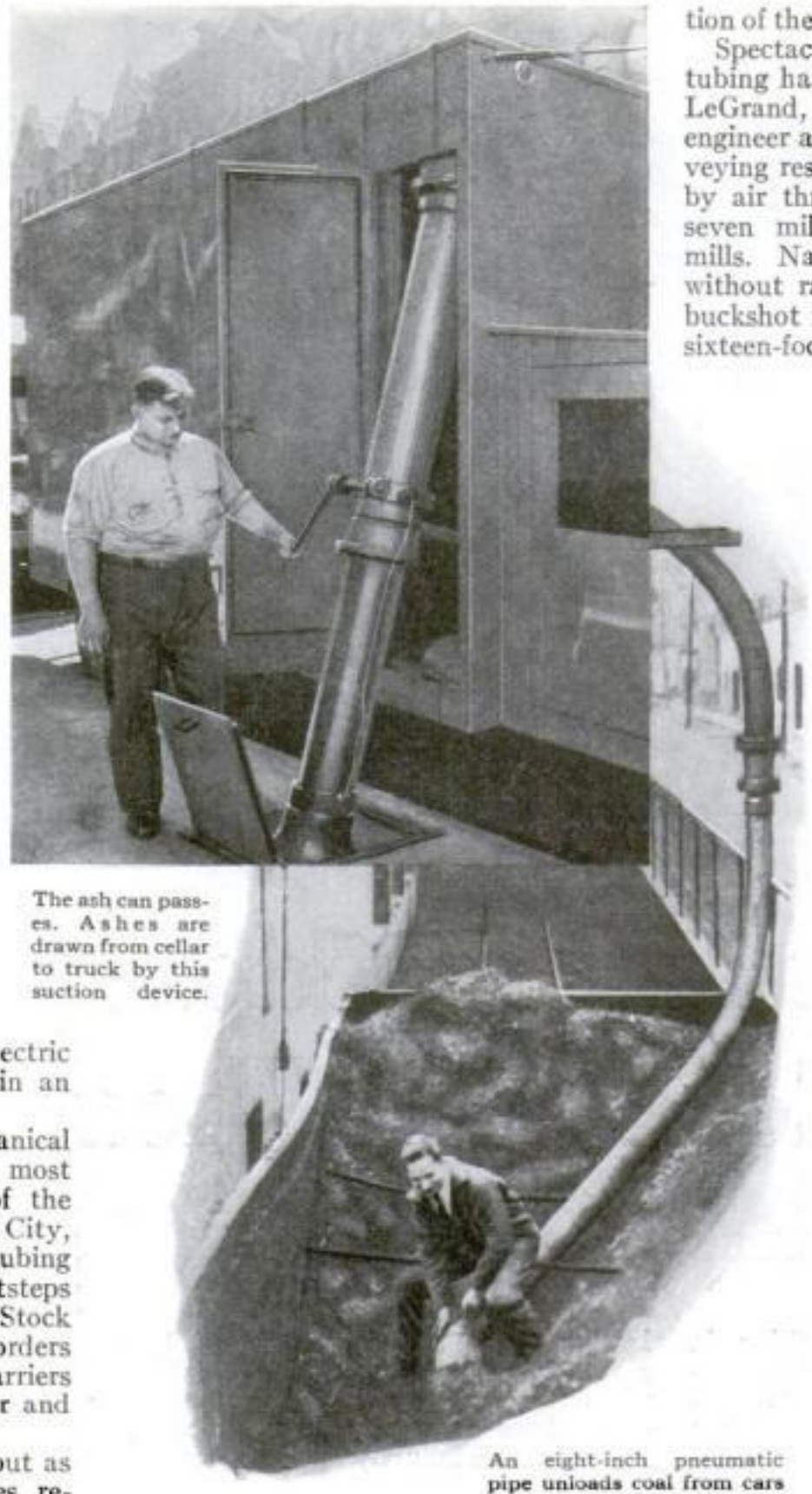
If one of the fourteen inch long carriers sticks in the tube—an unlikely happening, but possible if a careless operator dispatches two carriers too close together—a high-pressure air hose is attached to one of the tubes in the basement. A padded fitting makes a tight connection, and high-pressure air shoves the balky carrier through. Ordinarily the motive power for the great system comes not from compressed air at all, but from suction created by an electric blower as tall as a man, housed in an adjoining room.

An earlier installation of a mechanical messenger system, one of the most elaborate in the world, is that of the Equitable Building in New York City, which has ten miles of pneumatic tubing concealed in its walls. Fewer footsteps are heard, also, in the New York Stock Exchange, where all buy and sell orders are transmitted in pneumatic carriers about as long as a man's forefinger and about an inch thick.

Not alone as a message-carrier, but as an errand-runner, pneumatic tubes replace human labor. A St. Louis, Mo., hospital sends medicine and special instructions by tube from the dispensary to any part of the building. In an eastern steel mill, asbestos-lined pneumatic carriers rush 300 specimens of hot steel daily to the testing laboratory from blast furnace and other points. A recent unusual application is that in a New York theater, which uses tubes to convey cash from the box office to the treasurer's office as fast as it accumulates and thus reduces hold-up risk. And for sheer novelty few systems equal that of a Berlin cafe-owner. He installed a pneumatic system so that a patron could invite a lady at a distant table to dance, and even send her a flower, by tube.

IN INDUSTRY, as in commerce, the pneumatic tube typifies the machine age. Here air is generally used to blow loose substances through pipes. In only a few cases are carriers used—in an ammunition factory, for example, where four-inch cylinders carry loads of powder from the magazines to the cartridge-filling rooms.

The largest pneumatic system of its kind in the world unloads loose grain from barges at the New York State Barge Canal Terminal in Brooklyn, N. Y. Twin ten-inch pipes, lowered into the barge by a derrick, suck up 200 tons of grain every hour and deposit it in a near-by grain elevator. Another huge system built into a steamship solved the problem of unloading 2,000,000 pounds of cement at a time during the construction of the Merchandise Mart, in Chicago.



The ash can passes. Ashes are drawn from cellar to truck by this suction device.

An eight-inch pneumatic pipe unloads coal from cars into the plant of a dairy.

A pneumatic message system in a German cafe delivers dance invitations for guests.

Spectacular applications of pneumatic tubing have been worked out by Joseph LeGrand, Newark, N. J., air conditioning engineer and a pioneer in pneumatic conveying research. Wood pulp is propelled by air through tubes as long as six or seven miles in Louisiana and Oregon mills. Nails can be shot through pipes without rattling against the sides. Lead buckshot is air-borne in factories. Even sixteen-foot planks are "floated" on air in a forty-inch pipe.

COAL, too, may be conveyed by air. Once LeGrand was called upon to estimate the cost of building a 150-mile pipe line to transport coal by compressed air, with pumping stations every two miles. The project, which was to have been used for handling low-grade lignite near Charleston, S. C., was abandoned only after the initial cost of building a railroad was found to be cheaper. The pressure required to blow coal or wood pulp such distances is only five pounds to the square inch, according to LeGrand, while even a substance as heavy as lead requires only seven pounds' pressure.

Queer things are carried by industrial pneumatic tubes. A Denver mining company uses one to convey poisonous black arsenic from its smelter. Brazil nuts are shot 100 feet in a tube operated by a Brooklyn, N. Y., steamship company. Though the shells are slightly chipped, the eating qualities are unimpaired. A fourteen-inch air pipe is being installed in a New Orleans plant to carry crushed coconut hulls, known as copra, used in the making of coconut oil.

Industry and commerce are linked by communication—and "communication" again means, in many instances, pneumatic tubes which speed telegrams and mail. Of the fifty or more American cities that deliver telegrams by pneumatic tube between central and branch offices, Chicago and New York have the most elaborate systems. A man may file a telegram at a branch office and know that it is a matter of seconds only before a telegraph instrument at the central station will begin ticking it out over the wires. The return tube brings messages for local delivery. Each carrier holds eight telegrams, and darts through the two-and-a-half-inch pipes at a speed of a quarter of a mile a minute.

MAIL, too, goes by tube. Eight-inch tubes are installed by the Post Office Department in several large cities. They deliver the bulk of New York's mail in an underground system that operates twenty hours a day, regardless of sleet or snow that may disrupt traffic above. Using twenty-four-inch projectiles, propelled by compressed air, they connect every one of the (Continued on page 131)

An early type of Roman freighter, from a painting in the Vatican. Though it carried a mast, the ancient merchant vessel was propelled mainly by oars.

Sailing Down the Centuries

A Pictorial Story of Shipbuilding and Seafaring, from the Ancient Galley to the Modern Ocean Liner

EVER since the first primitive man to float down a river astride a dead tree discovered that he could propel himself by paddling with his hands, the story of man's conquest of the waters has been tinged with romance and adventure. The illustrations on the following pages record the most fascinating phases in the history of seafaring.

The raft probably was the first achievement in navigation. Then came dugout canoes carved from single trees, some of which archeologists have found associated with Stone Age objects. From these probably grew the idea for the use of bark. This lighter material necessitated the invention of internal framework, and so the ribbed canoe appeared. At first the hull undoubtedly was built before the ribs were inserted. The next step was to build the framework first and attach the hull to it. This marked the advent of one of the fundamental principles of modern shipbuilding.

For thousands of years paddles or oars must have been the only means of propulsion. Even after the invention of sails, rowing persisted for centuries. The earliest pictorial records of Egyptian vessels, dating back about 3000 B.C., show the banks of oars out in working array while the sails are furled and inactive. The naval power of Athens in her prime depended almost solely upon the famous triremes, so named because of their three banks of oars; and when Rome became mistress of the Mediterranean, the quinquireme, with five banks, was adopted as the principal ship of war. When peace was established, however, near the beginning of the Christian era, commercial vessels began to depend more and more on sail power. From the Middle Ages to the beginning of the nineteenth century the history of navigation is almost entirely the history of the sailing ship.

Many types of sails have been devised. The bellying curve of the lateen sail with its peak projecting above the masthead proved a terror to Mediterranean countries during the ascendancy of Mohammedan nations. After western Europe had assumed maritime supremacy, the great expanse of canvas of the square-riggers became the most familiar type of sail. This in turn gave way to the less majestic but more efficient fore and aft sail with its swinging boom.

The world's first really workable steamboat, built by John Fitch in 1788. Propelled by steam-driven paddles, it made several 20-mile trips on the Delaware between Philadelphia and Burlington, N. J.

In the eighteenth century, however, the reign of the sailing vessel was beginning to be threatened. The idea of using steam to turn paddle wheels began to be considered, but it was not until Watts's invention of the steam engine that such an idea was received with anything but ridicule. Marquis Jouffroy on the Seine in 1778, and James Rumsey on the Potomac in 1785, exhibited steamboats; and in 1788 John Fitch produced the first successful one. It was propelled by steam from Philadelphia to Burlington, N. J., a distance of about twenty miles. But the real beginning of steam navigation is generally dated from 1807, when Robert Fulton, after experiments in England and Paris, returned to America to launch the *Clermont* successfully on its first trip from New York to Albany.

Two years later the *Phoenix*, steaming from Hoboken to Philadelphia, was the first steamer to make an ocean voyage. The *Demologos*, the first steam warship, was built for the United States Navy in 1814–5. The next year, the first steamer ran across the English Channel and a line of steamers began to operate between New York City and New London, Conn. More important still was the twenty-five days' transatlantic voyage of the *Savannah* accomplished partly under steam propulsion in 1819.

One of the speedy clipper ships of the middle nineteenth century—the *Cowper*, built at Charleston, Mass., in 1854 and wrecked fifteen years later. These vessels demonstrated the speed advantage in slender lines.

THE first iron steamship, the *Aaron Manby*, ran in direct service between London and Paris in 1820.

In 1836 came perhaps the greatest innovation of all—the introduction of the screw propeller to replace the paddle wheel.

Meanwhile transatlantic steamship service began with the maiden voyage of the *Great Western* in 1838, and steamship companies began to multiply rapidly in both Europe and America.

Keeping pace with the progress along other lines was the improvement in ship's machinery from the single-cylinder engine of all early steamboats, through the introduction of the compound engine by John Elder in 1854, to the oil-burning steam turbines of a modern liner such as the record-holding transatlantic liner *Bremen*, and to the electrical drive for great vessels like the United States Navy's airplane carriers *Lexington* and *Saratoga*.

A palatial craft of the thirteenth century, reproduced from old records for the celebration of the 700th anniversary of the city of Lübeck, Germany. The old trader was armed with guns.

A faithful replica of an old Viking ship built in Norway, lying in the Thames off the Houses of Parliament. Propelled by oar and sail, these seagoing craft varied in size from the "skuta," with 30 oars, to the "ask," with 64 oars and a crew of 240, and to larger "dreki" or dragon boats.

Reproduction of *Santa Maria*, flagship of Columbus on his voyage of American discovery. Only 128 feet long, her fore and mainmasts were square rigged, and the mizzen had a lateen sail.

The *Flying Cloud*, one of the finest and fastest clipper ships ever built. On her maiden voyage in 1851 she set a record of 89 days for the voyage from New York to San Francisco. She was 229 feet long.

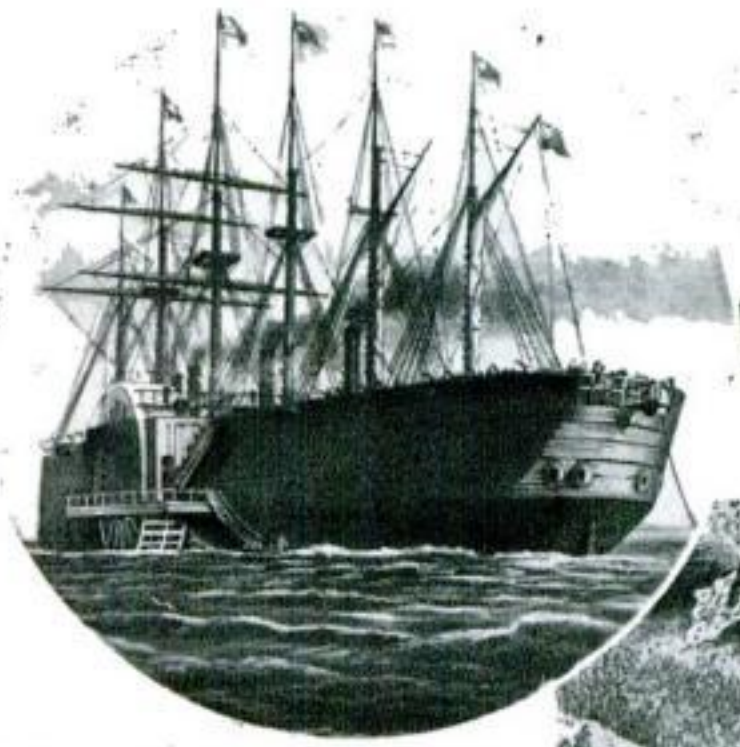
The five-masted ship *Kobenhavn*, said to be world's largest sailing ship. She is manned by cadets of the Danish merchant marine, many noblemen's sons. Her mainmast is 182 feet tall.

A famous five-masted barkentine, the *E. R. Sterling*, which weathered a terrific Atlantic storm two years ago. Her foremast is square rigged, and the four after masts fore-and-aft rigged.

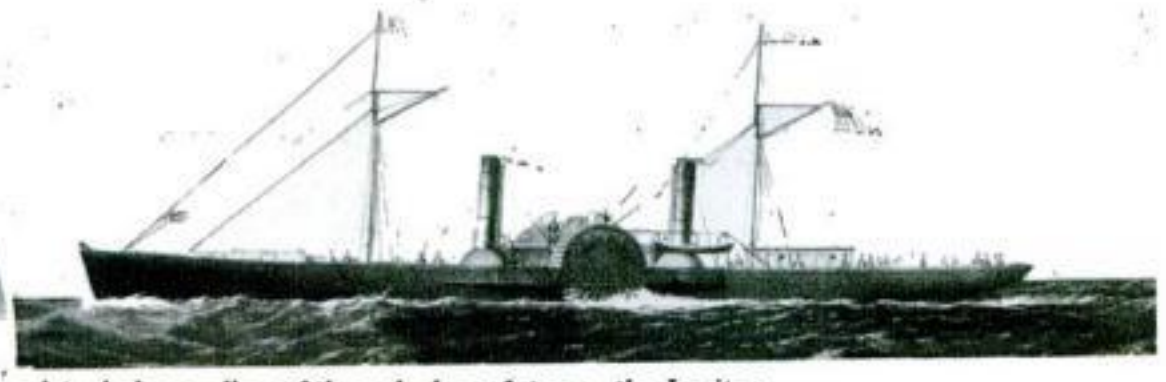
Eighty-odd years ago the *Charles W. Morgan* was one of the finest whaling ships of New Bedford, Mass. She is preserved on the estate of Col. E. H. R. Green.

The seven-masted steel schooner *Thomas W. Lawson*, built at Quincy, Mass., 1902. At that time she was the largest sailing vessel ever constructed—368 feet long, 50 feet beam, 10,000 tons displacement. She was wrecked off the coast of England.

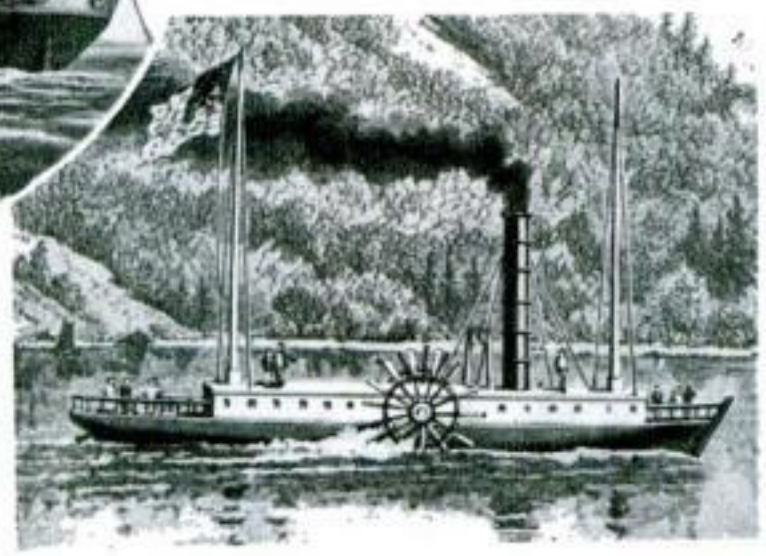
At the right is a full-size reproduction of the *Half Moon*, the little 80-ton vessel in which Henry Hudson discovered the river which bears his name, while attempting to find the northwest passage in 1609.



The iron merchant steamer *Great Eastern* laying Cyrus Field's Atlantic cable in 1865. When launched in 1858 she was the largest vessel afloat. At right: A replica of Robert Fulton's *Clermont*, first steamship in regular commercial operation, on the Hudson.



A typical ocean liner of the early days of steam—the *Jupiter* of Philadelphia under full power. Note the great paddle wheels; also masts and rigging for the use of auxiliary sails.



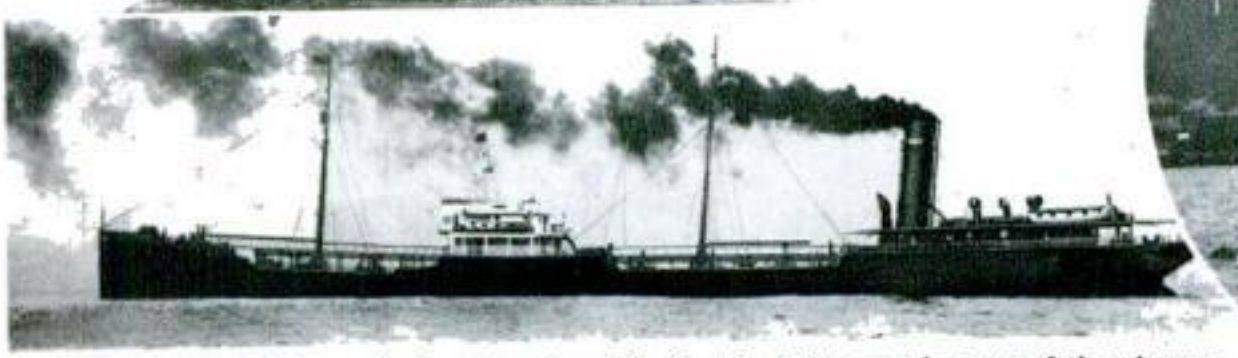
The wooden Coast Guard cutter *Bear*, for 39 years policeman, hospital, and supply base in Alaskan waters. She is succeeded by the steel cutter *Northland*.

The *Krassin*, famous Russian ice-breaker which, in the summer of 1928, drove through Arctic ice to rescue General Nobile and crew of ill-fated dirigible *Italia*.

The new German liner *Bremen*, fastest in the world, in New York harbor after her record-breaking maiden voyage across the Atlantic in four days, seventeen hours, and forty-two minutes. Later she clipped eighteen minutes from that mark.

At the right is the modern British cable ship *Cyrus Field*, named for the American promoter of the company which laid the initial transatlantic cable in 1858.

The powerful ice-breaking whaler *C. A. Larsen*, largest vessel of her kind, used by the Byrd expedition to Antarctic regions.



A typical modern freighter, the American steamship *Dartford*, after rescuing crew of the schooner *Ena A. Moulton* in a mid-Atlantic storm in 1928. At right: Anton Flettner's novel rotor ship *Baden-Baden*, after crossing the Atlantic. Revolving towers replaced sails to catch the wind.

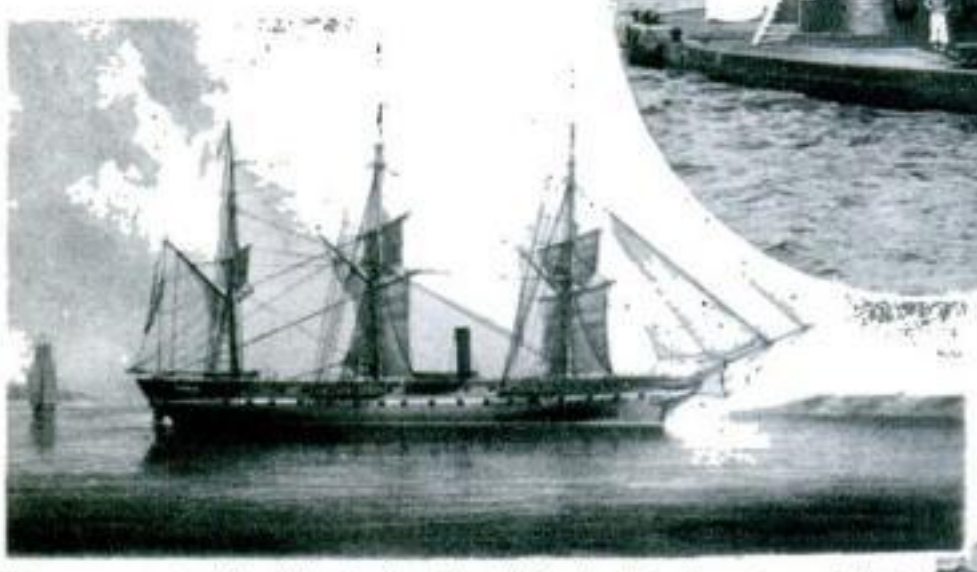
From Frigates to Plane Carriers

Picturing Advances in Warships Since the Day of "Old Ironsides"

Predecessor of the modern cruiser a typical U.S. frigate of the early nineteenth century. A three-masted, full-rigged vessel, it carried its main guns on a single deck.

The U.S.S. *New Mexico*, a first-line battleship built during the war and commissioned in May, 1918. Her length is 624 feet and her speed 21 knots. The main battery of 12 14-inch guns fires an 8-ton broadside.

America's first ironclad war vessel, the *St. Louis*, launched in 1851. At right: The ironclad turreted *Monitor*, invented by Capt. John Ericsson. Its victory in the historic battle with the *Merrimac* at Hampton Roads, Virginia, in 1862, proved the supremacy of metal-armored warships.

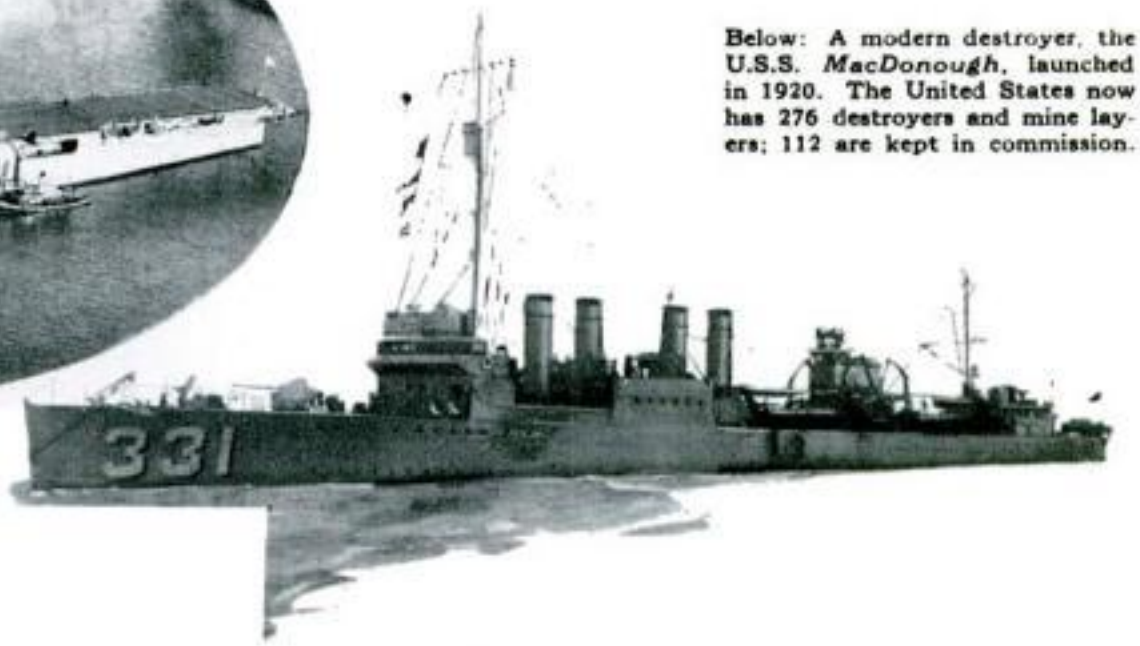


Steam power to the aid of sails—the *Wabash*, first class steam frigate launched in 1855, used during the Civil War, and flagship of the European squadron in 1872. Right: The U.S.S. *Monocacy*, American patrol boat on the Yangtze. With light draft, she steams 1,000 miles into interior China.

The U.S.S. *Colorado*, one of the finest of America's battleships, is an oil burner with electric drive. Airplanes can be catapulted from her decks.

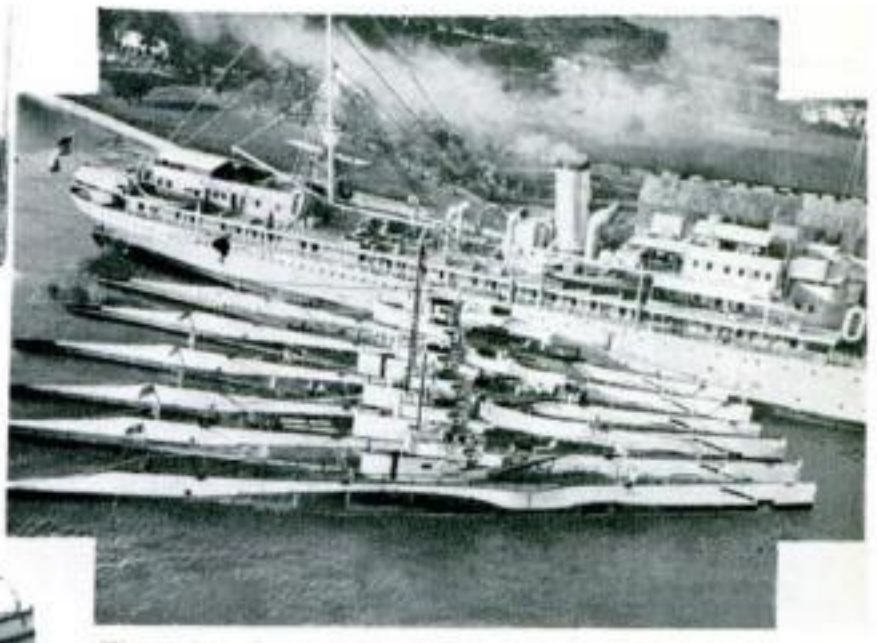
The U.S.S. *Constitution*, most famous of frigates, being reconditioned at Boston Navy Yard.

The $40,000,000 aircraft carrier *Saratoga*, commissioned in 1927, can carry 72 planes. She and her sister ship *Lexington* are America's two largest warships. The landing deck is nearly 900 feet long.



Below: A modern destroyer, the U.S.S. *MacDonough*, launched in 1920. The United States now has 276 destroyers and mine layers; 112 are kept in commission.

The U.S.S. *Relief*, the only all-hospital ship afloat, has accommodations for 550 patients and carries a staff of nine physicians. Her equipment includes X-ray, operating, and dental rooms.



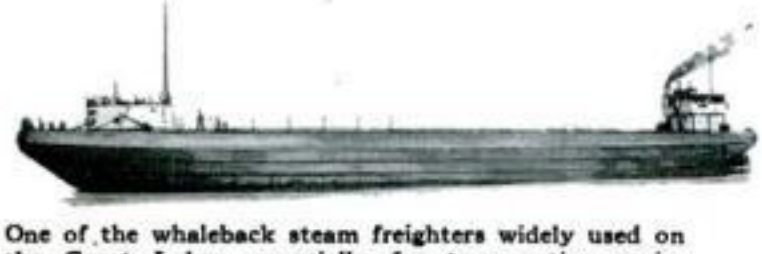
The submarine tender *Beaver*, one of six "mother ships" in the United States Navy, anchored with her brood of six undersea craft at a naval station in the Philippines. Most modern submarines have developed from the undersea craft invented by J. P. Holland in 1875.

Not the least important of naval vessels is the humble towboat. Here the Government tug *General R. N. Barchelder* is towing a target out to sea for naval gun practice.

Vessels of the Harbors and Inland Waters

An old-time stern-wheeler still in regular service in Florida. Particularly adapted to navigation in shallow waters, this type of craft is found chiefly on the Mississippi and streams of the South.

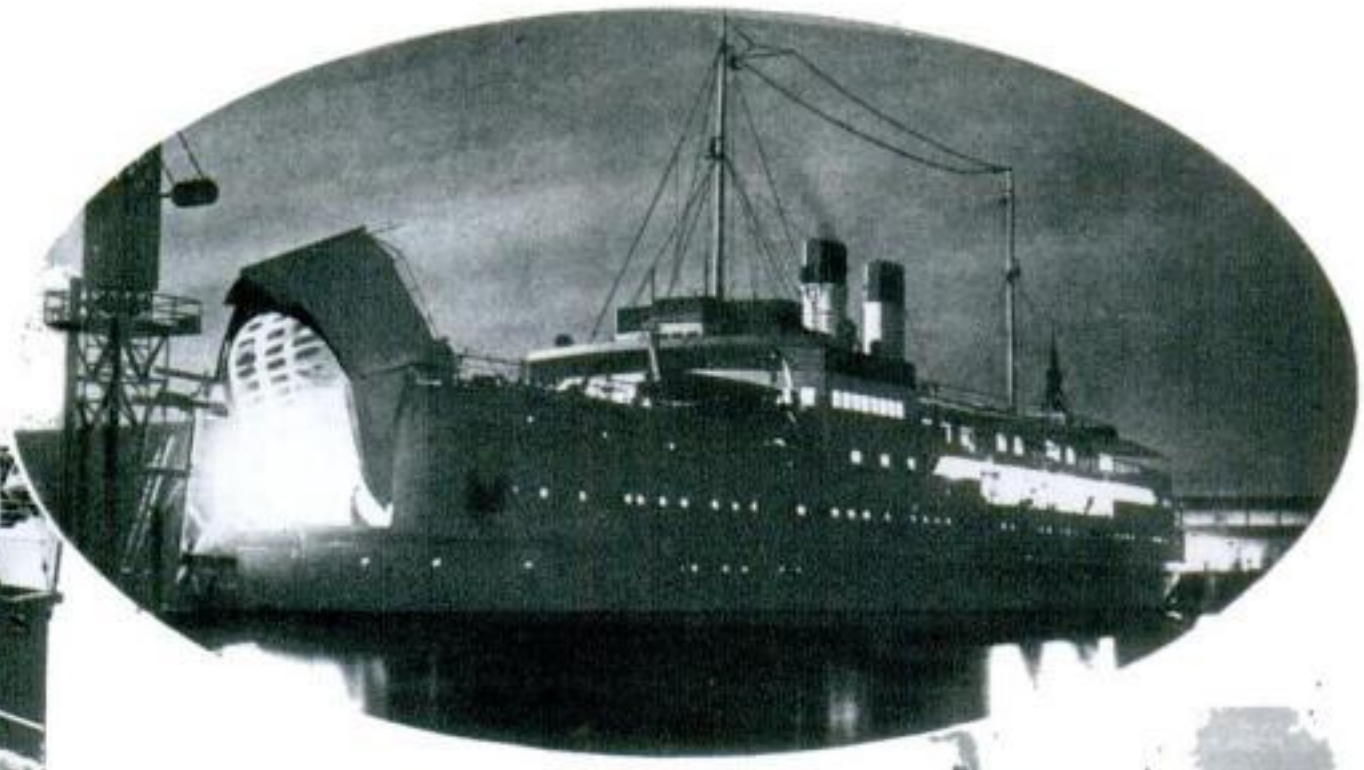
This small ferryboat, of a type once common, runs on Lake Champlain from Montcalm Landing, N. Y., to Powell, Vt.



One of the whaleback steam freighters widely used on the Great Lakes, especially for transporting grain. Curved sides, a spoon bow, and a convex upper deck are characteristics from which these vessels get their name.

Once the U.S. monitor *Amphitrite*, this floating clubhouse appeared first off Florida coast; later on Long Island Sound.

A British pleasure steamer, the *Crested Eagle*, carrying a full load of passengers to Margate, a seaside resort on the Isle of Thanet.



The German deep-sea ferryboat *Schwerin*, plying across the Baltic Sea between Denmark and Germany, carries two steam trains and 100 passengers.

Powerful fire boats in Boston harbor demonstrate their ability to protect property along the water front. Each craft pumps thousands of gallons of water a minute into a blaze.

Docking the White Star liner *Majestic*, one of the two largest vessels in the world, calls for the combined efforts of eight tugboats. This photo shows them warping the great liner into her pier.

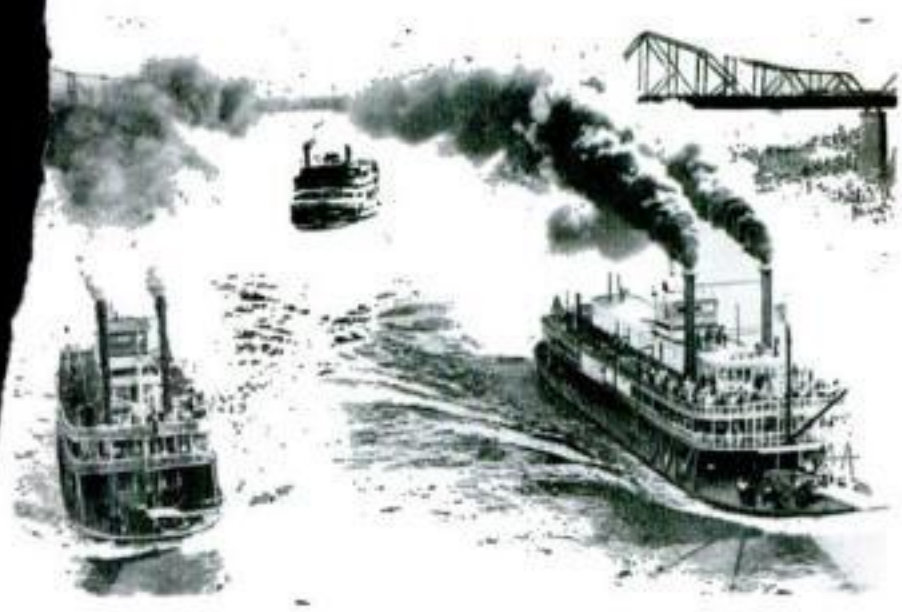
One of the floating elevators which load shipments of grain for foreign ports into the holds of steamers in New York harbor. Its bucket conveyors lift the grain from barge to steamer.

Two of the modern 650-ton steel barges built for the New York State Barge Canal, the $100,000,000 waterway from Buffalo to the Hudson River.

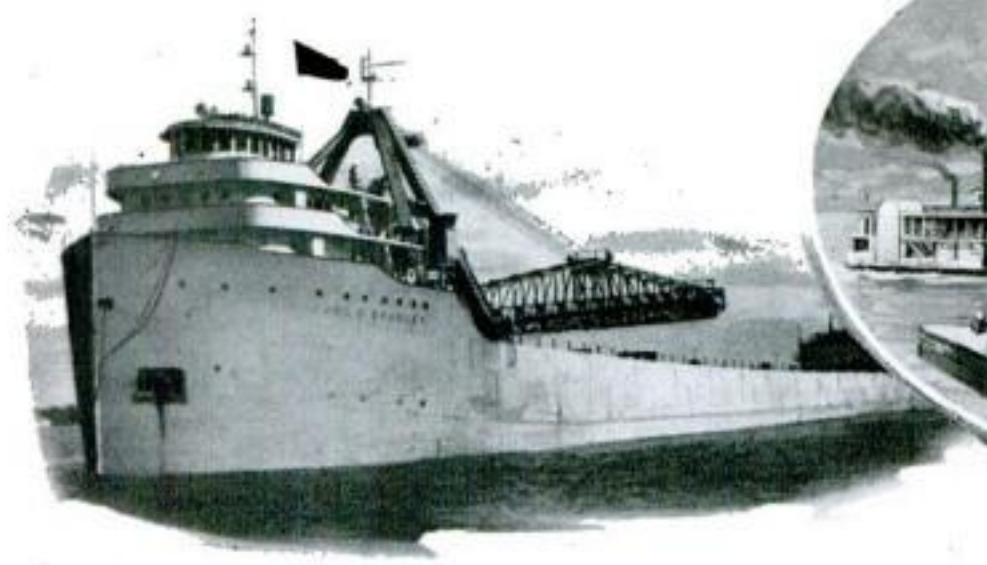
One of a vanishing line—the stern-wheeler *Hannah* carries passengers and freight out of St. Michael, Alaska.

A cattle boat in New York harbor. It transfers cattle from New Jersey receiving yards to outgoing steamships.

Right: One of the finest Hudson River steamers, the *Washington Irving*, sunk in 1926. Below: A Cape Hatteras lightship.



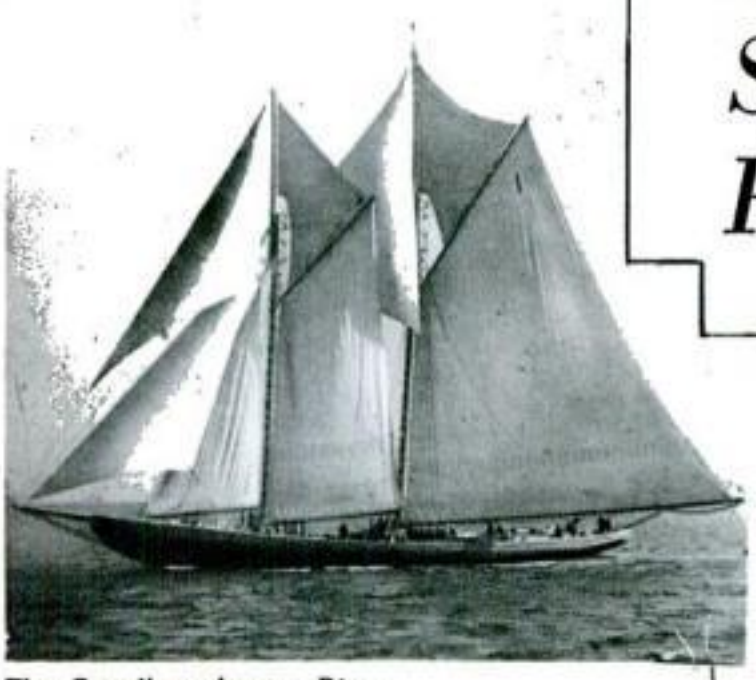
Reviving the romance of early river steamboating—a thrilling race between the packets *Betsy Ann* and *Chris Green* on the Ohio River, 1928.



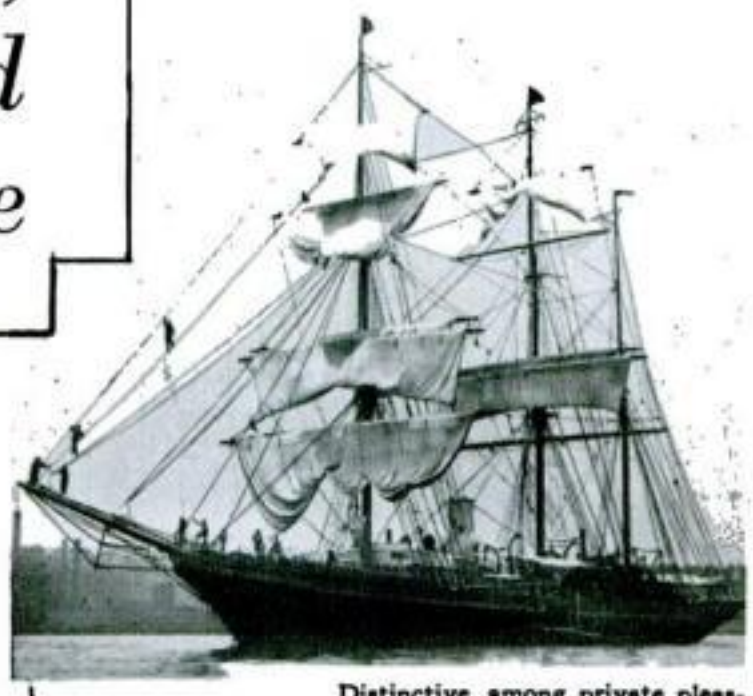
The limestone carrier *Carl D. Bradley*, largest vessel on the Great Lakes. This steel freighter is 638 feet long and will carry 15,000 tons of stone.

An old-time scene at a sugar plantation on the Mississippi. In the foreground is a flatboat of the kind that Lincoln, as a youth, took down the river to New Orleans. It was handled with long sweeps. Above: A whaleback passenger steamer on the Great Lakes.

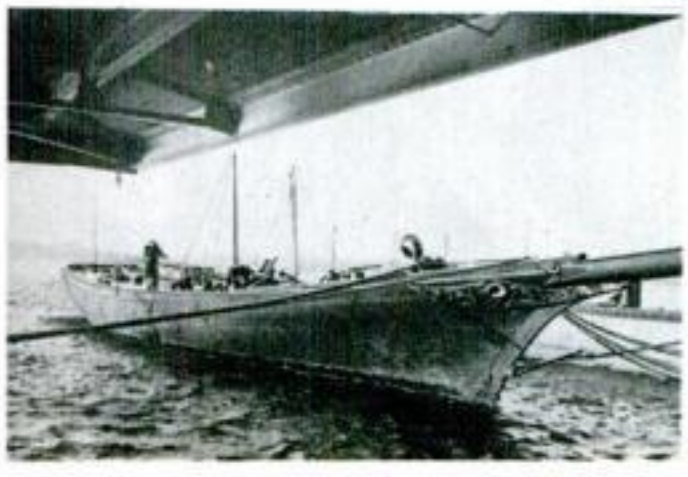
For Speed, Sport, and Pleasure



The Canadian schooner *Bluenose* of Lunenburg, Nova Scotia, claims the title of being the fastest fishing schooner afloat. Undefeated, she holds the international fishermen's trophy.



Distinctive among private pleasure craft is the auxiliary bark *Aloha*, owned by Arthur Curtiss James, New York capitalist. It combines a three-masted sailing vessel with a Diesel-driven yacht.



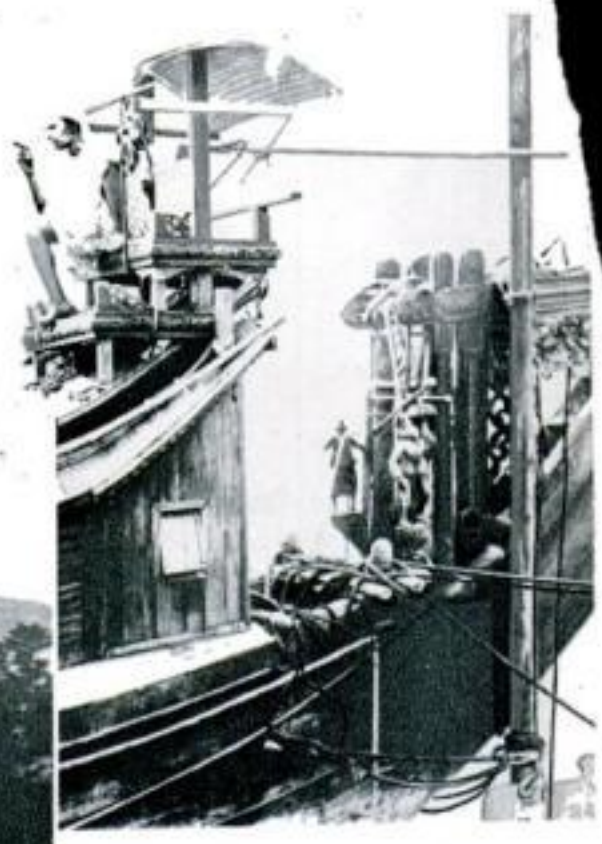
The $2,000,000 *Orion*, largest yacht in the world, built at Kiel, Germany, for Julius Forstman, of Passaic, N. J. She is 333 feet long and is equipped like an ocean liner. Diesel motors drive her.

Two 250-horsepower airplane engines with air propellers drive the novel French speed boat at the right, called the "water glider."

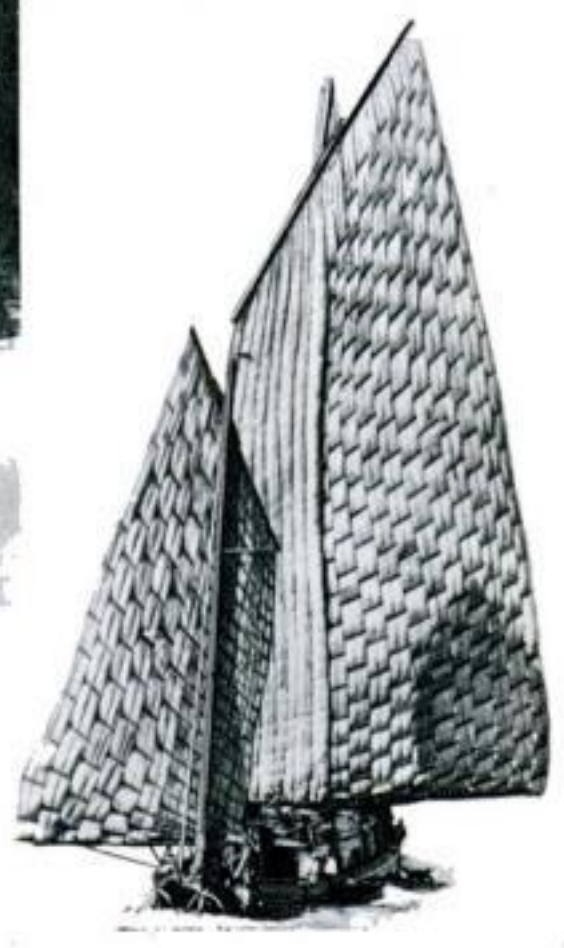
At the left is the hull of the famous schooner *America*, first winner (1851) of the international yachting cup which bears her name.

Curious Vessels of the Orien

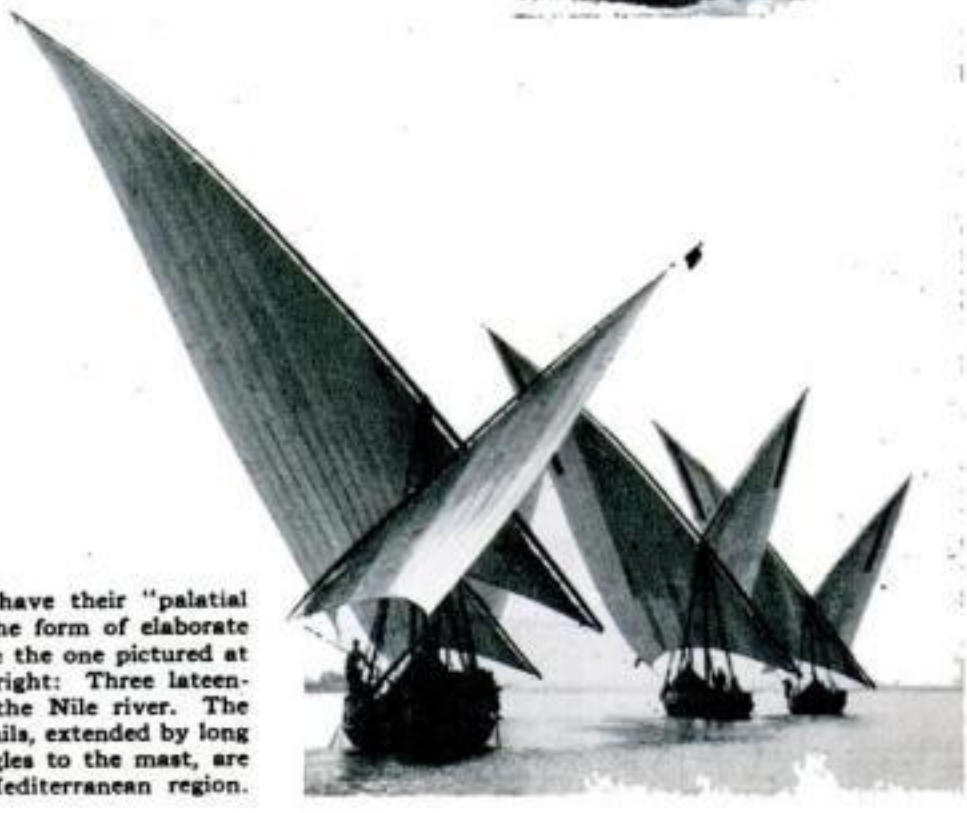
With square sails of matting, the *Amoy* (at left) is a typical awkward Chinese junk. Note the "eye" painted on the hull to ward off evil spirits of the deep. At the right is an old-time Burmese sailing craft, decorated with curious carvings. The lookout sits near the stern on a high throne, which really is an ancestor of the modern bridge.



Yachting in Japan, with a mountain in the distance. A crude square sail and a sweep at the stern keep the small craft moving. At left: A Fiji Island sailing canoe with outrigger to prevent tipping. Right: Another Chinese junk, with immense expanse of coarsely woven sail



Wealthy Chinese have their "palatial yachts," too, in the form of elaborate floating houses like the one pictured at the left. At the right: Three lateen-rigged dhows on the Nile river. The triangular lateen sails, extended by long yards slung at angles to the mast, are peculiar to the Mediterranean region.



Keeping Pace with Aviation

After a successful maiden voyage of 300 miles—the new British dirigible *R-101*, largest in the air, anchored to its mooring mast at Cardington.

The World's Largest Dirigible and Flying Boat Make Good—New Airplane Records and Promising Inventions

A NEW "world's largest" dirigible, Britain's oil-burner *R-101*, left its hangar at Cardington, England, recently for a successful maiden flight. Its first 300-mile cruise, followed by a longer flight a few days later, seemed to contradict recent assertions by at least one prominent British engineer that the craft was underpowered, structurally unsafe, and "already obsolete."

The *R-101*, like its sister ship *R-100* just completed, has a gas capacity of 5,000,000 cubic feet, nearly half again as great as that of the *Graf Zeppelin*, German dirigible and formerly the world's largest. In shape it is fifty feet shorter and thirty feet thicker than the *Graf*. Its outstanding feature is the use of heavy oil instead of gasoline or inflammable gas for engine fuel, to reduce fire hazard.

The new dirigible is 750 feet long, 130 feet in diameter, and weighs 150 tons. Its maximum lift is 150 tons, and its cruising range is 4,000 miles. A remarkable feature is that cabins, saloons, and everything except the control cabin and engines are inclosed within the envelope. An upper deck area of 5,550 square feet is devoted exclusively to one large lounge. Designed for service between England and India, the craft is built to carry 100 passengers at a speed of sixty-three miles per hour.

At present there are six superdirigibles in existence or under construction in the world. Abroad are the British *R-101* and *R-100*, and the German *Graf Zeppelin*, while the United States has the *Los Angeles* and is building at Akron, Ohio, two air leviathans that will eclipse in size any now completed. The ceremony of "laying the master ring" of one of these superliners was scheduled to take place recently. This is comparable to laying the keel of an ocean liner or battleship, since the central ring is the first of the circular pieces that will form the hull. Enough of the huge hangar has been completed to shelter the airship being built.

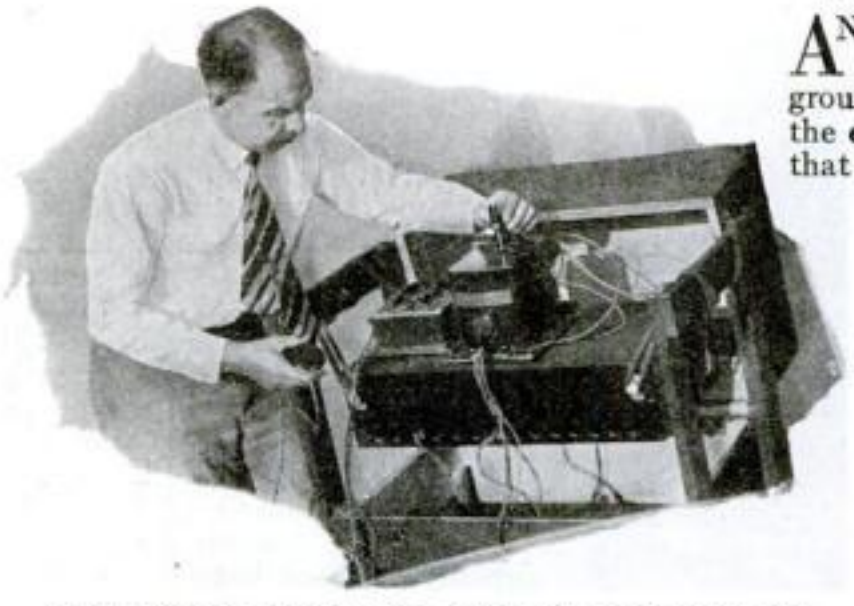
Meanwhile it has been announced that the *Graf Zeppelin* will start April 1 on its heralded Arctic voyage of exploration under the scientific leadership of Dr. Fridtjof Nansen, famous Norwegian polar explorer.

France Tries Oil Motors

OIL-BURNING airplane motors are to replace gasoline engines in all French military planes, following their official adoption by the French Air Ministry. The plan is to make the gradual substitution first in the school training planes, and later in all army and navy aircraft.

Engineers regard this step as one of the most radical of recent years in aviation progress. Oil-burning motors are considered much safer than those using gasoline, because of the difficulty of igniting accidentally the heavy oil that is burned. Recent progress has been made in this country and abroad in adapting "Diesel" or oil-burning engines to aircraft use, and a plane so powered recently made a successful flight from Detroit to Langley Field, Va. Nevertheless the rather excessive weight of an oil motor hitherto has been considered a handicap to its practical use.

The French government's decision follows announcement of a new lightweight type of motor invented by P. Clerget, French engineer, which reduces this weight to about four and one half pounds per horsepower. It is a nine-cylinder engine, like the successful American model, and develops 100 horsepower.



Leo P. Delsasso, inventor of a naval sonic depth-finder, analyzing sounds with one of the instruments used in his experiments to develop a new sound-reflection type of airplane altimeter.

A New Altitude Recorder

AN INSTRUMENT that will project sound waves from an airplane to the ground, receive the echo, and translate the elapsed time into the number of feet that the airplane is above the earth, is now being tested in experiments conducted at the University of California, Los Angeles, Calif. Leo P. Delsasso, inventor of a naval sonic depth-finder, is engaged in the work of applying the principles of sound reflection to this new type of altimeter. For two years, it is said, Delsasso has been analyzing the sounds made by an airplane, and the results of this study will be used in adapting the principle of the marine instrument to the air.

The new instrument is designed

to record changes in the ground level, such as mountains and hills, which would not be revealed by the ordinary barometric pressure type of altimeter.

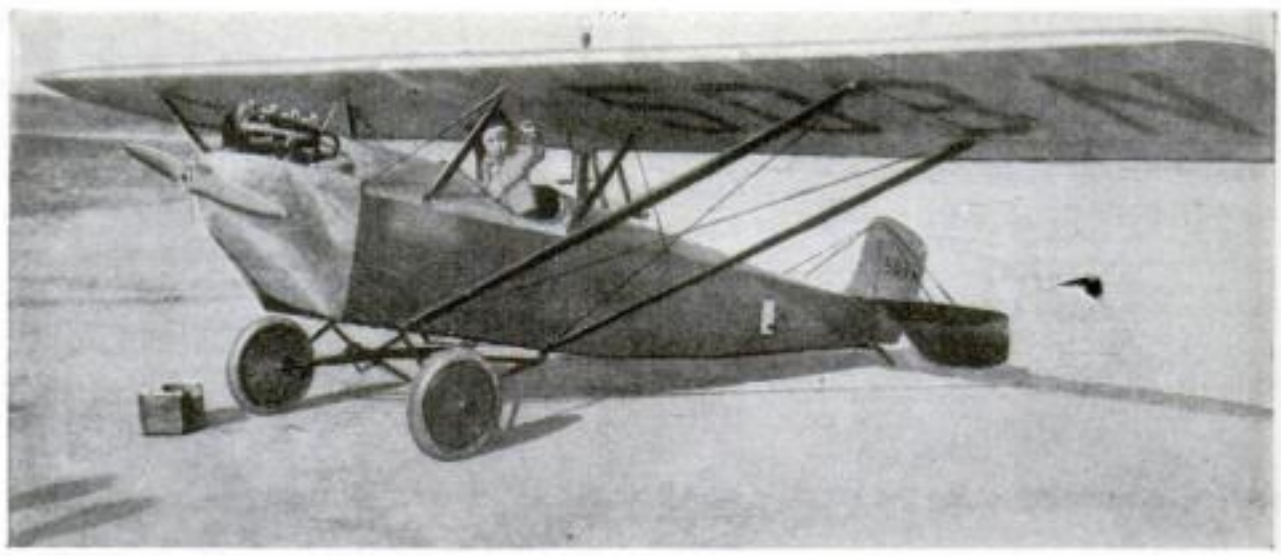
A 227-Mile Aerial Photo

SHOOTING at an invisible target with an aerial camera, Capt. A. W. Stevens, United States Army Air Corps photographer, recently obtained the most distant photograph ever made. The target was Mount Rainier, 14,000-foot peak in the state of Washington, and the distance was 227 miles from the Oregon point where Captain Stevens was flying at an altitude of nearly 17,000 feet.

The object of the test was to demonstrate the possibility of clear, long-distance photography for military purposes. It was made possible by the use of camera filters that cut out all but invisible, haze-piercing "infra-red" light, which was recorded by photographic plates especially sensitized to these rays by a new process.

Captain Stevens and his pilot, Lieutenant John Corkille, could not see Mount Rainier when the picture was taken. Stevens pointed the camera in what he believed was the right direction and snapped the shutter. When the plate was developed, the shadowy image of the distant peak was clearly visible. An interesting feature was that it appeared in the photograph to be lower than nearer, less lofty mountains, due to the curvature of the earth. Measurements to be made on the photographs may support the suggestion, however, that objects actually below the horizon may be photographed by long-distance cameras on account of the possible bending of light rays to follow the earth's surface.

The honor of taking the highest aerial photograph also belongs to Captain Stevens, who photographed Dayton, Ohio, from an official height of 37,854 feet.



Almost like a toy is the miniature monoplane built by two mechanics at the Granite City Airport, near St. Louis, Mo. It is only 16 feet long, with 25½ feet wing spread, but can speed 75 miles an hour.

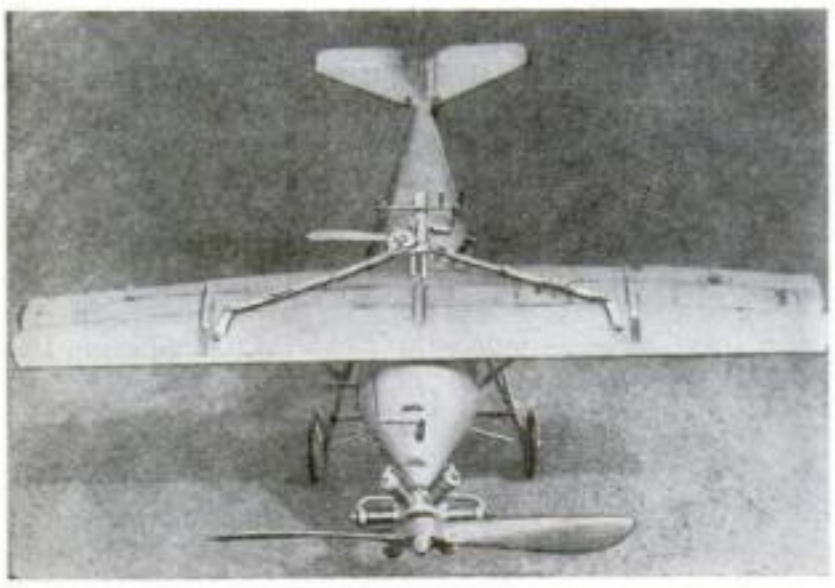
First four-seater, all-metal autogiro designed by Juan de la Cierva, and tested at Pitcairn Field, Philadelphia, Pa., preparatory to the commercial manufacture of "windmill planes" on a large scale.

FOR swift travel the public is taking to the uncongested air—and to the water as well. An article in a forthcoming issue tells of the surprising part motor boats are playing in the modern scheme of transportation.

Invents Expanding Wing

TAKING off from the ground with the wings of his plane spread wide, the pilot of the future may operate a control to make the wing surface narrower for speed flying, and operate it a second time to restore the wings to their full size for landing. Such is the prediction of Fred Ries, of Compton, Calif., who has invented airplane wings which, it is claimed, will contract and expand freely to meet the needs of the moment.

Ries's new shrinkable wings are built in three sections overlapping lengthwise like a telescope and fastened together in three places by metal hasps that slide freely in grooves to permit the parts to open or close. The spread of the wings is controlled from the cockpit by a gear mechanism back of the wings over the fuselage, which regulates two jointed arms.



Model of an airplane equipped with new shrinkable wing, showing mechanism by which the pilot may enlarge the wing surface for taking off or landing, and reduce the surface for speed flying.

Now—A National Air Ambulance

THE first commercial ambulance service by airplane has just been organized, according to an announcement of the New York City firm that sponsors it. It offers day and night service between New York and any point in the country having an adequate landing field.

Airplane speed may save the lives of patients by a quick dash from remote sections to a metropolitan hospital. Also the transit will be smoother in a plane than in a jolting automobile ambulance. Space in the planes will be adequate to accommodate doctors and nurses to attend the patient.

The largest planes of the service will carry relatives and friends as well.

New Distance Mark

BY A nonstop flight of nearly 5,000 miles, Dieudonne Costes and Maurice Bellonte, French airmen, have apparently shattered all records for a distance hop. Leaving Paris recently with Tokio as their announced objective, they all but completed the ambitious flight. They were finally forced down near the village of Tsitsikar, Manchuria, in the northeast corner of China.

Although reports of the exact distance covered are conflicting, the shortest possible airline distance between Paris and Tsitsikar, a check shows, is approximately 4,930 miles. That is about as far as the distance between London and Seattle, Wash. The previous nonstop distance record was made by two Italian airmen, Captain A. Ferrarin and the late Major C. P. del Prete, who covered about 4,400 miles in a flight from Rome to Brazil.

Up with 170 Passengers

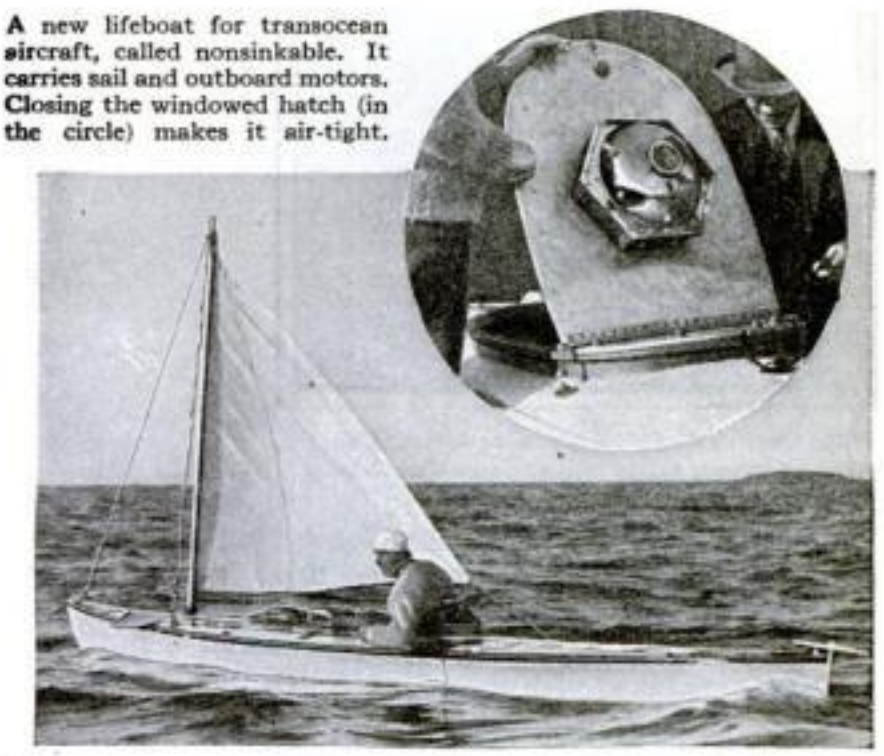
WITH 169 persons numbered in the official list of passengers and crew, the Dornier monster seaplane *DO–X* recently made a flight of nearly an hour over Lake Constance, Switzerland. A four-year-old boy not counted in the records brought the total to 170 persons, by far the largest number ever taken aloft at once, either in airplane or dirigible, in the history of aviation.

This achievement marked the latest of nearly forty successful flights of the German seaplane. On this occasion it lifted a dead weight of fifty-two tons into the air. Despite the enormous weight, it landed on the lake surface so smoothly that many of the passengers, who were sitting on benches and chairs, were not aware of it.

A transatlantic flight tentatively scheduled for next (Continued on page 134)

Camera Shots of Flying Progress

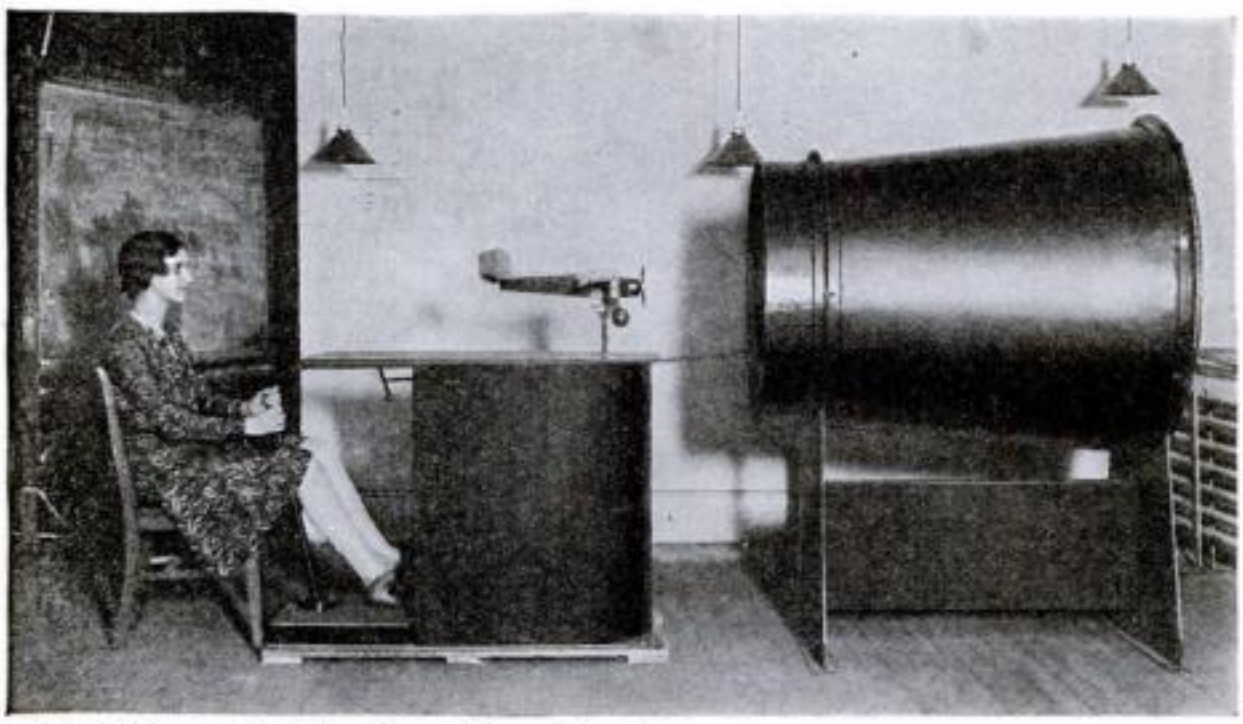
Students learn the fine points of parachute jumping in a new parachute school opened in Chicago. Jack Cope, holder of the world's record delayed opening jump, is instructor.



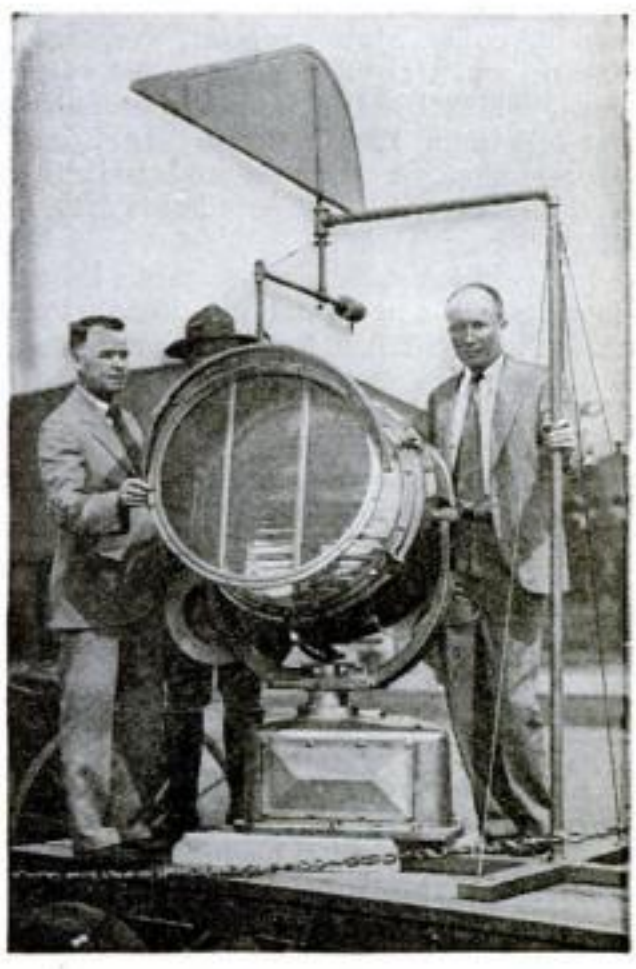
A new lifeboat for transocean aircraft, called nonsinkable. It carries sail and outboard motors. Closing the windowed hatch (in the circle) makes it air-tight.

Launching the *Pernambuco*, flagship of a fleet of twin-motored Sikorsky amphibian airplanes for the 6,000-mile New York-Buenos Aires line.

A newly designed testing stand for airplane engines at Madison, Wis. Engine is below and control room above.



The latest method of teaching aviation, introduced in the first women's flying school at New York University, is that of "piloting" model planes. The model, placed in the wind stream of a small wind tunnel, is controlled by the student with a regulation stick. Thus she learns the secrets of turning, banking, looping, and so on as a preliminary to the first actual airplane flights.



An improved type of revolving airport beacon, pictured at the right, is equipped with a wind direction indicator to aid pilots in landing at night. This indicator, invented by Maj. Francis Boyle, U. S. Army, throws a colored beam of light a mile or more into the wind.

The earth's birth—a gaseous projectile, shot from the sun, condensed to form the planets.

The Earth Is *Two Billion* Years Old

New Tidal Theory Explains How the Planets Sprang from the Sun

By THOMAS ELWAY

ONE day, eons ago, as the lonely, planetless sun, a rotating ball of white-hot gases, was drifting through space, it was partly disrupted by the close approach and gravitation of another large, swift-moving star.

The terrific attraction of the new star raised two enormous tides of gas on the sun, one on each side. As the bulging sun continued to revolve, two great waves of gaseous fire, thousands of miles high, rolled around its surface during each rotation.

These hot tides became too vast for the sun's own gravitation to hold back. Bit by bit, gas was sprayed out from the tidal crests as though the summit of an ocean tide erupted a giant geyser. So immense were these outbursts, so speedy the jets of white-hot gas as they escaped, that at least one long, sausage-shaped projection of gaseous solar matter stretched itself out on the side toward the passing star. Perhaps a similar cosmic blimp shot out from the other tide, on the opposite side of the sun.

Some of this solar gas condensed, forming eight planets and some of their moons. One of these planets, as small beside its parent sun as a pea beside a volley ball, was the earth.

The mighty celestial upheaval that created the earth and the planets Mercury, Venus, Mars, Jupiter, Neptune, Saturn, and Uranus took place not more than 3,000,000,000 years ago and probably not less than 1,300,000,000. In round figures, then, it may be said that the birthday of the earth occurred 2,000,000,000 years ago.

Such, in substance, are science's latest answers to the perennial questions: How old is the earth? And how did it originate?

THE new hypothesis regarding the earth's beginning, known as the tidal theory, was worked out principally by two distinguished British scholars, Sir James Jeans and Dr. Harold Jeffreys, both of whom have published books upon the subject within the last few weeks.

Among the happenings on the earth's birthday was the creation of a gaseous dusty veil behind which the sun is believed to have disappeared until the series of planets was fully formed. Dr. Jeffreys calls this veil the "resisting medium." And it is from this that he derives his best hints about the latest date at which the earth's birthday can be placed.

Not all of the gas that spurted out of the sun during its encounter with the passing star collected into the globes of the planets. Much of this solar gas must have remained in space as gas or perhaps as myriads of tiny globules cooled to particles of solid dust. Dr. Jeffreys says that this vast cloud of dust and gas probably revolved around the sun, together with the newly created planets. Like drapery on an Oriental dancer, the sun's veil whirled with its owner, a cosmic dust-dress spangled with cooling worlds.

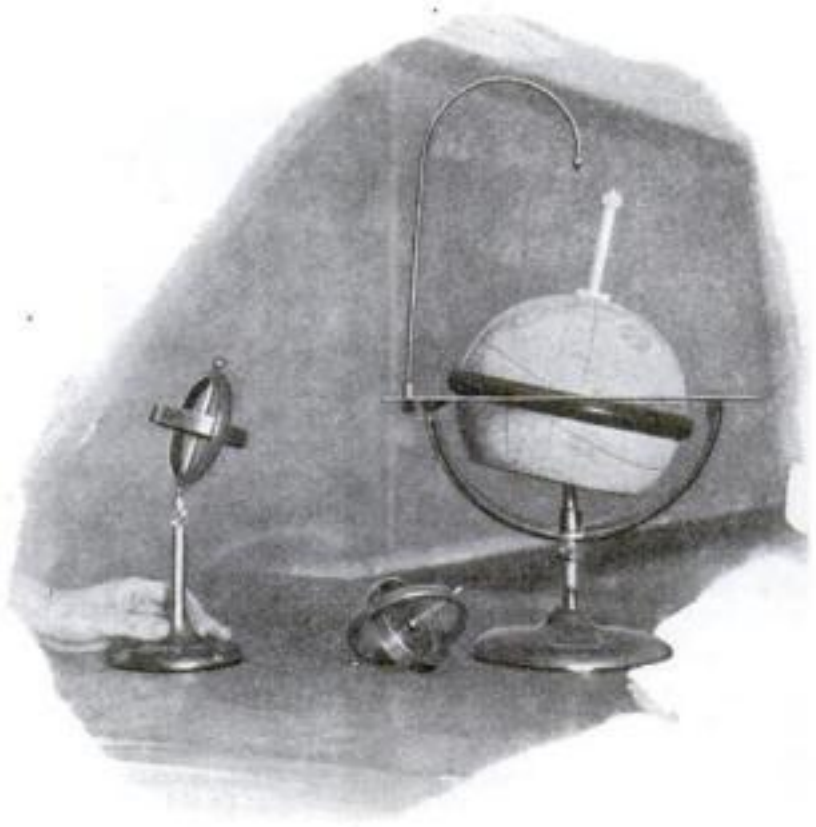
Thus spinning with the sun, this dust cloud would not slow up the motion of the planets in their orbits to make them fall ultimately into the sun, as a dust cloud at rest in space would do. But even the spinning cloud would have one planetary effect. It would make the orbit of each planet as nearly a circle as possible, for only by moving in an exact circle around the sun could a planet reduce to a minimum the friction encountered from the dust cloud.

The orbits of the planets certainly were not all perfect circles in the solar system's beginning, or even as near to circles as most of these orbits are today. Instead, the orbits of the inner planets, in particular, were probably stretched out into lengthened ellipses, like cross sections of footballs. For the planet Mercury, smallest of the solar system and closest to the sun, for example, Dr. Jeffreys has calculated what this elongation of the original orbit was just after the earth's birthday. Astronomers know what the orbit is now—very nearly a circle. The difference gives a measure of how potently the dust cloud of the sun's veil must have worked on this orbit to make it a circle between that remote birthday and today.

It is possible, too, to calculate about how thick the original veil was and about how fast it would operate to convert the lengthened orbit of Mercury into a circle. With the preceding data, that permits calculation of the orbit's age—in other words, of the birthday of Mercury. And since Mercury and the earth were born at the same time, this same date must have been the birthday of the earth. It is safe to say, Dr. Jeffreys concludes, that this date cannot have been later than 1,000,000,000 years ago.

IN SEARCHING for the earliest date that may mark the terrestrial birthday, help comes from the earth's crust. In some of the rocks are minerals containing uranium, a chemical element which turns very slowly into lead—about one half of it in five billion years. Analyzing these minerals to discover how much uranium and how much lead they now contain, geochemists compute the number of years since each was formed in the earth's crust. Such age estimates, made from uranium and lead minerals in many parts of the earth's crust, indicate, says Dr. Jeffreys, that the earth's crust cannot be younger than about 1,300,000,000 years, and probably is not older than 3,000,000,000 years. These are the limits between which must lie the missing date.

The 1,000,000,000-year minimum calculated from the orbit of Mercury is confirmatory. A midway date of about 2,000,000,000 years ago fits everything, including another limiting date which can be calculated from the time probably necessary for the former veil of dust and gases to be absorbed completely into the sun except



Models illustrating effects of the earth's rotation and shifting of axis—results of the stellar encounter which formed the earth.

for its small present remnant, probably a thin disk in the plane of the earth's orbit. This memento of the earth's creation is believed to be responsible for the dim, conical glow in the sky, pointing upward from the horizon like a thick finger, which may be observed on spring nights and which astronomers call the zodiacal light. Thus the earth's birth date is written in the heavens and also stamped upon minerals which are buried deep beneath its own crust.

The tidal theory of the earth's origin really is a modification and elaboration of two earlier hypotheses. One, advanced in France in 1796 by Pierre Simon, Marquis de Laplace, is called the nebular hypothesis. Stating that all the planets of the solar system might have been formed out of matter left behind in the slow contraction of a great gas ball or nebula, the condensed mass of which is the present sun, this nebular hypothesis was taught universally in the schoolbooks until less than thirty years ago.

ABOUT a century after its promulgation, mathematicians found that the theory was impossible and it was abandoned. That left the earth, so far as science knew, without a beginning, but other theorists hastened to bridge the gap. Two professors then at the University of Chicago, the late Dr. T. C. Chamberlin and Dr. F. R. Moulton, who has since left the field of education for that of business, elaborated a new idea—the so-called planetesimal hypothesis. According to this idea, the earth and the other planets, like the goddess Minerva who, in Roman mythology, sprang full-fledged from the head of Jupiter, were born from the body of their father, the sun. It was this theory which first pictured the great solar adventure as having resulted from the close approach of another star, whose proximity and gravitation disrupted the sun.

As has been seen, this part of the hypothesis was taken over by Sir James Jeans and Dr. Jeffreys. But another part, involving the so-called planetesimals, which gave the theory its name, has been rejected. These planetesimals, as their name implies, were considered to be very small, very numerous bodies like minute planets, pulled out of the sun by the near approach of the other star, soon chilled to solidity by the cold of space, and then gathered up one by one to form the mass of greater planets like the earth, just as the globe continually encounters meteorites at present.

IN THE Chamberlin-Moulton interpretation, the earth scarcely had a definite birthday. Like Topsy, it just grew, little by little and millenium by millenium as it gathered up the planetesimals in its path. Like the earlier nebular hypothesis, this portion of the planetesimal hypothesis has proved to possess fatal mathematical flaws.

First of all, it implies that the earth was never molten but merely grew together bit by bit out of ice-cold planetesimals. Certain geological facts, however, indicate that the earth once was molten. Secondly, mathematicians compute that such a cloud of planetesimals never could have combined into a solid planet but, if it changed into anything at all, would have produced a cloud of hot gas generated by mutual friction and collision. Another defect of the hypothesis lies in the calculation that the planetesimals never could have produced the changes now believed actually to have taken place in the shapes of the planets' orbits.

Tidal theory of the earth's origin. Enormous tidal waves of fiery gas were formed on each side of the sun by the close approach of another star. At least one of these projections was pulled away.

Starting from the same idea of the near-coming star, the tidal theory assumes that the matter drawn out of the sun was gas instead of solid planetesimals.

The tidal theory of what happened on the earth's birthday explains many things about the solar system. It accounts for the fact that all the planets revolve around the sun in the same direction and very nearly in the same plane, like runners circling a central pillar in a stadium. Direction and plane, of course, are those in which the visiting star went by. The theory explains, too, why the outer planets are less dense than the inner ones, for the less dense chemical elements were probably more plentiful in the outer layers of the primitive sun and went farther when the gases jetted out during the encounter.

This suggests that the outer planets Uranus and Neptune, perhaps even Jupiter, may be worlds with atmospheres of light gases such as hydrogen or helium, instead of the denser gases of the earthly air.

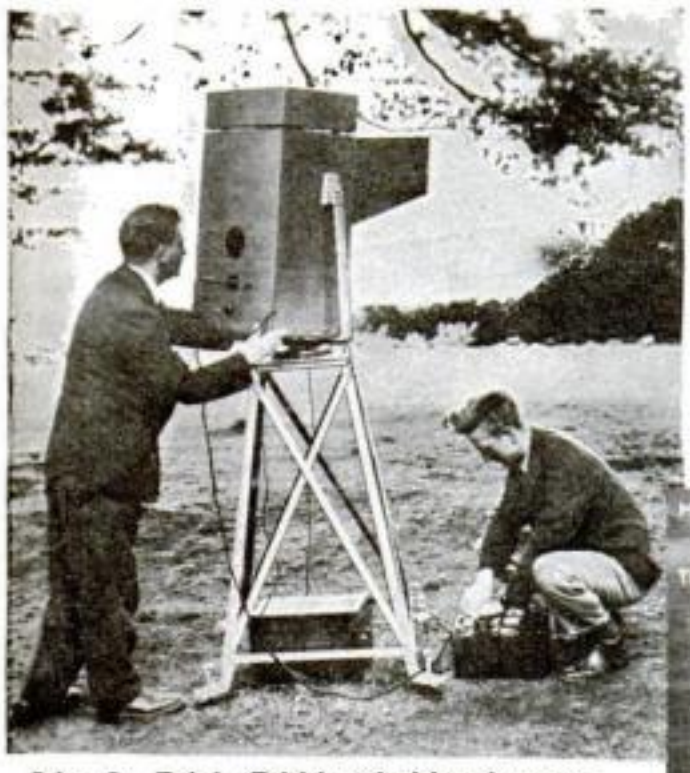
Sometime in the early youth of the earth, before its crust could have much more than cooled, the adolescent planet suffered a similar convulsion to that which gave the planets birth, astronomers believe, but one more violent in proportion. This was the birth of the moon, a body believed to have been formed by the tidal disruption of an earth still hot and liquid in its interior. The cause was the gravitation of the sun. Some geologists hold that the deep basin of the Pacific Ocean is the scar left when the moon was torn away. It has not been possible, as yet, to calculate the ages of the earth and the moon from their present mutual relations. But there are indications that this may be possible some day, when it will provide a check on the calculations from the orbit of Mercury.

IN THE moons of other planets, too, and in the orbits and characters of those mysterious small planets called asteroids circulating between Mars and Jupiter—objects still quite unexplained by any theory of solar-system origin—it is probable that future astronomical mathematicians will find other possible measures of the earth's age; other celestial horse-teeth which may be examined to see how far time and circumstances have worn them down. Meanwhile, a date about two billion years ago is the experts' best estimate for our planet's birthday. Until some more exact figure is proved by further discoveries, this approximate date is likely to be accepted.

WHAT are the stars made of, and how were they formed? Mr. Elway will tell of astronomy's latest answers to these mysteries in another article which will appear in a forthcoming issue.

Rays *That* Penetrate Fog *and* Darkness

By GEORGE LEE DOWD, JR.



John L. Baird, British television inventor, adjusting his "noctovisor"—an infra-red ray detector he designed for "seeing in the dark."

Infra-red rays were used by Capt. A. W. Stevens, Army Air Corps, to take this photo showing Mt. Rainier 227 miles away.

BACK from an expedition off the coast of Newfoundland, in which new methods of detecting icebergs were tested, Dr. Howard T. Barnes, of McGill University, Montreal, Canada, is reported to be working on a device for revealing fog-hidden icebergs to mariners through the agency of infra-red rays or "black light." This is the newest practical use suggested for these invisible rays, which have been put to work in secret military telegraphy, in long-distance photography, and in seeing in the dark by television. Soon the strange beams may be employed in beacons to guide ships through fog, and may guard homes against burglars. In industry, they may stop trains automatically at a danger signal or halt a factory machine when an operator's hand strays too near an exposed gear.

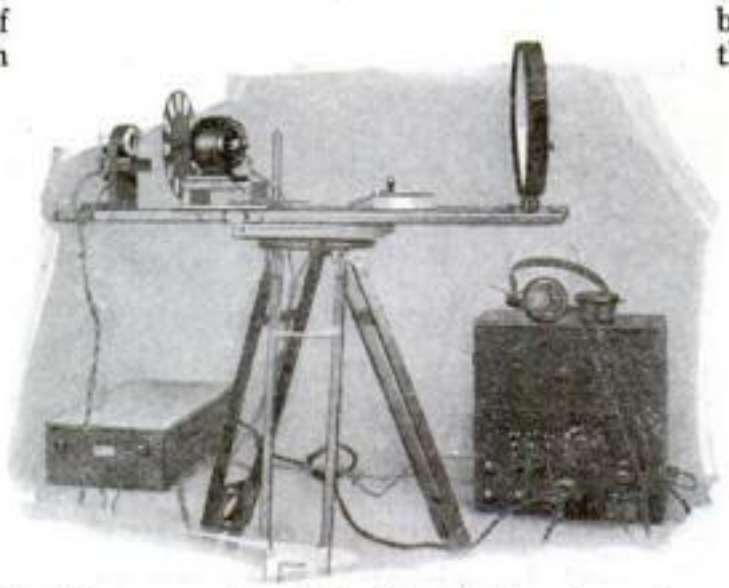
"Radiant heat" is another name for infra-red rays. The heat of a bonfire beside a track is felt through the window glass of a railroad car by infra-red rays. It is not ordinary heat, for, like light and radio waves, the infra-red beam traverses empty space as well as air. Like light, it can be focused by mirrors and lenses. It has a definite place in the scale of ether wave frequencies. Its vibrations are below the threshold of sight, its name meaning "below the red." This distinguishes the rays from the "ultra-violet" rays of sunlight and health lamps.

For a long time little was known about this newly unexplored "ray-region." Now the rays promise to open up worlds of application. They penetrate human flesh to a depth of several inches, and therefore have a marked curative value in certain rheumatic conditions. They pierce fog and mist to greater distances than any other known forms of light. They are not stopped by haze, as are ultra-violet rays. Hence they are both invisible and powerful.

When an ordinary searchlight—one source of infra-red—is covered with a dark sheet of glass which has been coated with copper oxide or a black sheet of ebonite, it looks pitch dark. Actually the dark beam is streaming through. Sensitive electric cells can detect it miles away. Working out a practical principle that would combine the beam and the electric cells, Government experts during the war in the United States and France evolved secret infra-red signaling systems which probably would have been utilized in Army and Navy service had the war gone on. John L. Baird, the English television pioneer, was stimulated by these experiments to invent a so-called "noctovisor"—literally an electric eye that could see in the dark. In a dark laboratory he made dolls visible on a distant screen by radio vision by a device similar to television machines, the dolls being lit by dark infra-red beams instead of by visible light.

The electric detecting cells used to pick up the rays are similar to the photo-electric cells or "electric eyes" of daytime television and talking movies except that they are especially sensitized to infra-red rays. They will respond to the impact of a ray in such an amazingly brief time that they can register as many as 100,000 individual impulses per second. It is this capacity that fits them for, signaling and television in the dark.

An infra-red beam is a heat beam, and its heat may be detected. This discovery opens up another field of application, the acute detection of icebergs being one of the possibilities. The electric thermometer or thermocouple is capable of detecting the heat of a candle six miles away, and the bolometer, even more sensitive, can respond to a beam causing a temperature change of only one five-millionth of a degree. In Dr. Barnes's device, the iceberg is tracked down by the scarcity of infra-red rays coming from its direction, due to its low temperature. Contrarily, the presence of another steamship in the fog can be revealed by the heat of its funnels. The hot funnel broadcasts rays in all directions, and the thermometer picks them up and betrays the latitude and longitude of the ship.



Receiving apparatus of the infra-red signaling system developed during the war by the U.S. Bureau of Standards.

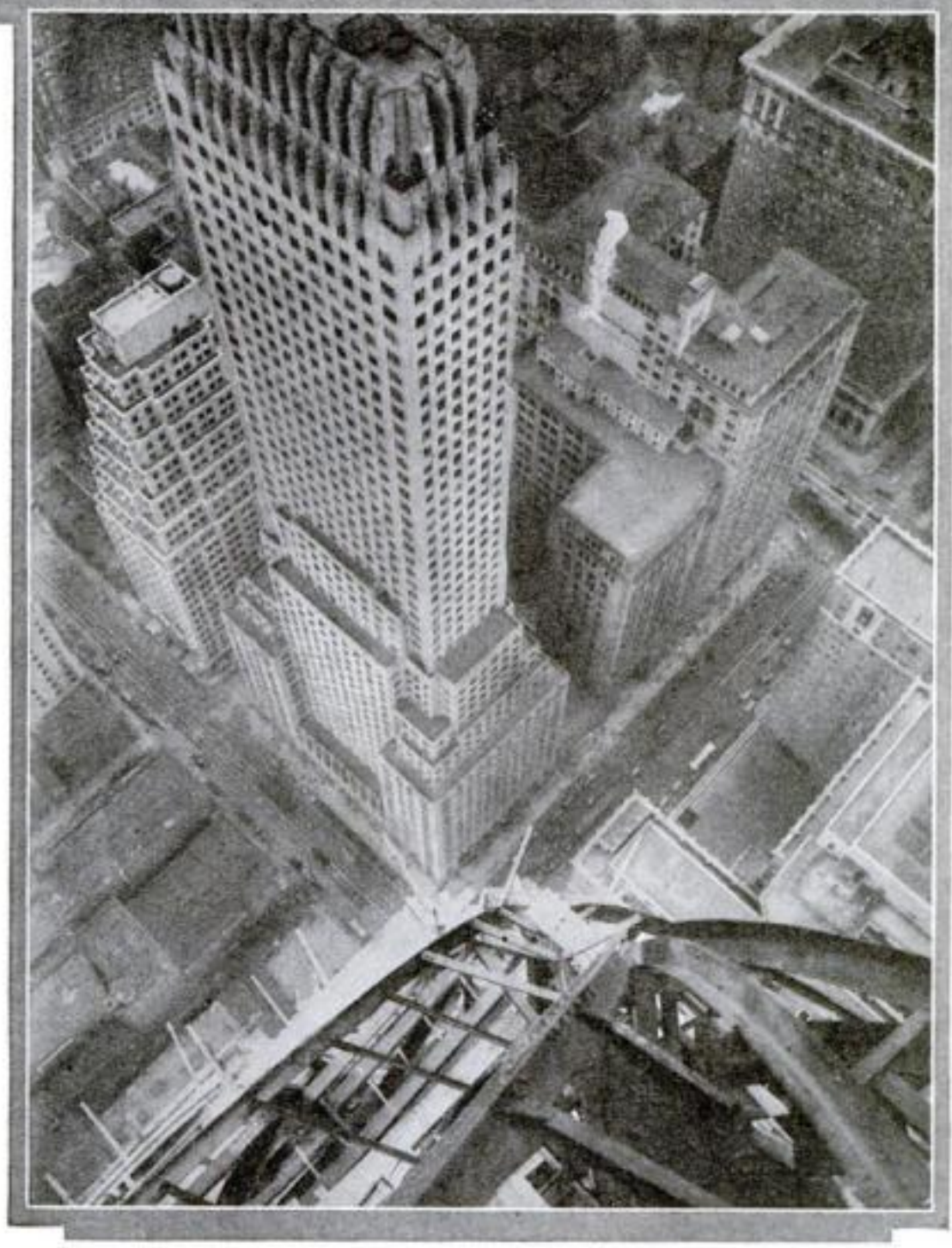
ALTHOUGH the eye cannot see infra-red rays, the camera can. Newly-developed plates specially sensitive to the rays have uses in aerial and distance photography, astronomy, medicine, and metallurgy. Elsewhere in this issue is described the feat of Capt. A. W. Stevens, of the Army Air Corps, who recently used infra-red rays to photograph Mt. Rainier in Washington through a haze at a distance of 227 miles. Ivan Bertrand and L. Justin-Besancon of Paris have succeeded in taking photos of kidney cells by a process involving a stream of the rays through a microscope (P.S.M., Nov. '29, p. 145). They are being used to study the obscure action of fluxes used in welding, by taking pictures of the blinding flash at the tip of a welding rod (P.S.M., Dec. '29, p. 30). Furthermore, astronomical photographs of Mars and Venus taken by infra-red light have yielded the most up-to-date information about their surface and atmosphere.

All these discoveries of new uses for infra-red rays have been very recent. Only four years ago the writer of a popular book on physics dismissed the rays in this summary manner: "Below the longest color waves—the red—are, as we saw, the waves of radiant heat, and we need add little about these." Now engineers are just commencing to learn what tremendously important things infra-red rays may turn out to be.

Back of the Month's News

By

KARL VOOGHT



Looking down nearly 850 feet from the spire of the world's tallest skyscraper, the new 75-story Chrysler Building at Forty-Second Street and Lexington Avenue, New York.

AT LEAST five prominent rivals of the world's tallest skyscraper, the 792-foot Woolworth Building, are at this writing projected in New York City.

Already well advanced in construction is the Chrysler Building of seventy-five stories, 850 feet. Definitely authorized is the Empire State Building, to occupy the former site of the Waldorf-Astoria Hotel and to rise eighty stories, approximately 970 feet. A little shorter will be the National City Bank-Farmers Trust Company Building in downtown New York, which is expected to tower seventy-one stories, 925 feet. Fourth of the contestants is the projected new tower structure of the Metropolitan Life Insurance Company at Madison Square, announced as probably 100 stories but as yet of undetermined height. Fifth, and apparently to be tallest of all, is the proposed Lefcourt Building in the Times Square area of the city, for which a height of 1,050 feet is being considered. Chicago is not far behind these New York giants, with the Chicago Tower Building planned for a maximum of 880 feet.

WITHIN the memory of the majority of living business men engineers presented weighty arguments to prove that twenty stories, then thirty stories, and finally forty stories would be the ultimate maximum of skyscraper construction. As has happened so many times before in technology, these negative pronouncements turned out to be flimsy guesses. Somewhere, within the next few years, the 100-story record undoubtedly will be accomplished or eclipsed. Perhaps before readers of this paragraph are dead, 200 or 300 stories will be a fact among the skyscraping homes of big business organizations.

It becomes increasingly evident that the limitations to skyscraper heights are economic considerations, not engineering ones. In a recent study by the American Institute of Steel Construction, it was decided that on land valued at $200 a square foot a sixty-three-story building costing approximately $39,000,000 would give the maximum return on the investment; a rate computed at ten and one quarter percent. Doubling the value of the land would provide maximum profits for a structure reaching seventy-five stories into the air instead of sixty-three. The more valuable the land the higher the skyscraper which can be built on it economically.

Once there was a belief that skyscraper heights would be definitely limited by considerations of elevator speed. Every floor to which a skyscraper rises necessitates elevator service. Every elevator uses up so much ground space for its shaft. Obviously there must come a point of increased height at which the ground area used for elevator shafts takes up so large a fraction of the building site as to destroy the chance of profit for the builder. This can be minimized by increasing elevator speed, so that one elevator carries more traffic and serves a larger fraction of the building. Recent conclusions that skyscrapers of 200 stories or more are possible rests upon the probability that this elevator speed may be increased almost indefinitely.

NEXT month a leading American psychologist tells of "Springs That Move the Human Mind"—explaining the brand-new "Gestalt" theory and comparing it with the Freudian and other ideas of human behavior.

Hottest Flame Cuts Anything

A FLAME hot enough to eat its way into an iron safe like an auger into cheese—even hot enough, it is probable, to melt a hole in a stone wall as a volcano melts out rock to form lava—has been invented by Dr. Frank M. Strong, of Syracuse University. The heat producer of the new super-torch is powdered, metallic aluminum burning in a blast of high-pressure oxygen gas.

That many metallic dusts are combustible is well known to chemists. Powdered magnesium is the essential constituent of the well-known flashlight powder used by photographers. Iron dust may be set on fire in an atomizer of oxygen with a brilliant pyrotechnic display. Dust of metallic thorium, under proper conditions, will set itself on fire brilliantly and hotly by mere contact with air, as has been proved by Dr. Harvey Rentschler, president of the New York Electrical Society and research director of the Westinghouse Lamp Works.

Aluminum dust as a heat producer is already familiar in the mixture called thermite, in which the powdered aluminum is mixed with powdered oxide of iron. When this mixture is ignited the aluminum dust exchanges partners chemically with the oxide of iron, the aluminum and the oxygen combining while the iron is set free as molten metal. In this case not all of the energy of the combination between aluminum and oxygen can be set

free as heat, for some of it must be used to decompose the oxide of iron. This loss of heat Dr. Strong avoids by providing oxygen gas with which the aluminum can combine.

In his torch, a stream of aluminum dust is mixed mechanically with a stream of high-pressure oxygen. This mixture, supplied through eight separate pipes, is focused on the flaming point of the torch. So great is the affinity of aluminum for oxygen that the mixture may be touched off with a match. The temperature attained is great enough, Dr. Strong reports, to cut through any known solid substance.

Timing the Earth

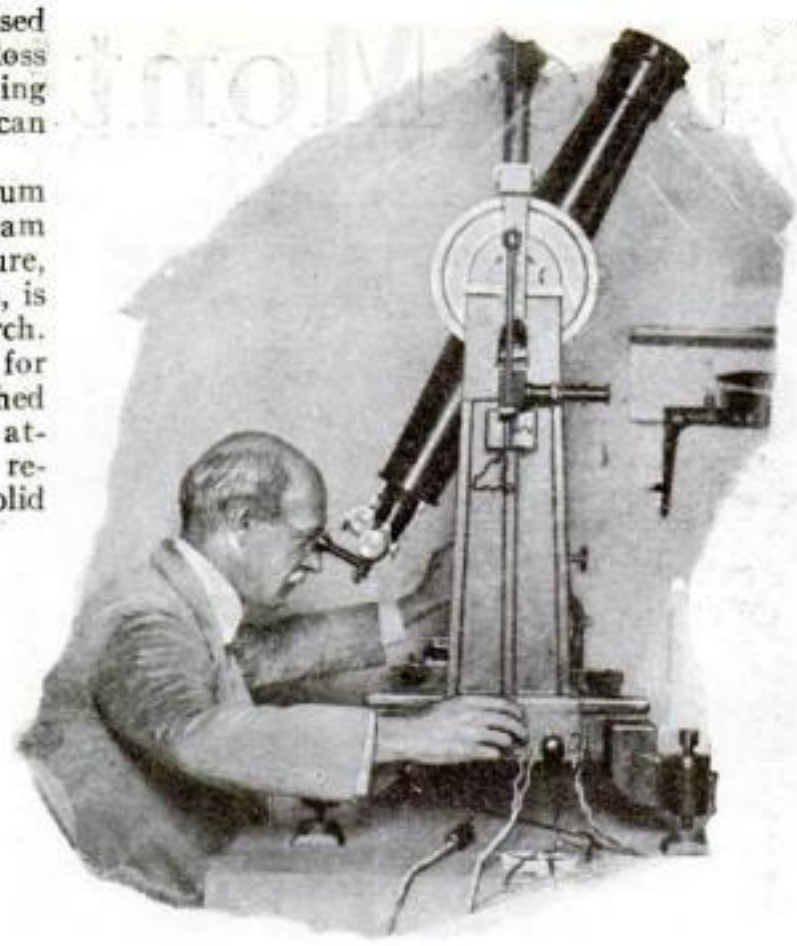
A NEW way to make the earth time its own rotation, as though a foot racer carried a stop watch to time himself, has been devised by Captain Frank B. Littell and J. E. Willis, of the United States Naval Observatory, in Washington.

The earth's rotation is taken by all scientific men as a fundamental standard of time. By it are regulated the clocks of all civilized countries. To make sure that the astronomical clocks which keep this world time are always correct, they are checked at intervals by observing the apparent motion of the stars. From the instant a star passes precisely above an astronomical observatory tonight until the instant that same star passes overhead tomorrow night is precisely one day.

USUALLY this fundamental time unit is measured by a human eye. Looking through a telescope pointed directly overhead, an astronomer observes the instant at which the image of a selected star passes across a fine spider web inside the telescope. At that instant the astronomer presses a button which serves to check the error, if any, of the observatory's clocks. One difficulty of this method is the introduction of what is called the "personal error"; due largely to the time which the astronomer needs to see the coincidence of star and spider web and to work the muscles necessary to press the signal button.

To avoid such errors the Washington astronomers have devised their new method. Installed in Washington is a special telescope called a Ross Reflex Photographic Zenith Tube. Light rays from stars almost directly overhead enter this vertical tube through a lens and strike a surface of metallic mercury at the tube's bottom. Thence they are reflected to a photographic plate. As the whole tube turns with the rotation of the earth, star images make tracks across this photographic plate.

Captain Littell and Willis have attached to this Ross telescope devices by which each tick of the observatory's clock moves the photographic plate of the telescope a trifle. Thus the trail made by a passing star consists of a series of dots or dashes on the plate, not a continuous line. Just before the selected star is to pass directly overhead, the position of the photographic plate is changed. Two lines of dots or dashes are thus produced, one for the star trail before the change of plate position, the other for the star trail afterward. By measurement and computation of these, the astronomers determine the precise fraction of a clock-tick at which the star was exactly vertical.



Captain Frank B. Littell, of the U. S. Naval Observatory, with the new telescopic precision instrument utilized for checking the world's standard time. Directed at a given star, it literally makes the revolving globe time its own rotation automatically.

The New Hydrogen Twins

THE discovery of a new pair of twins is not often world-wide news, but an exception occurred recently at the meeting of the American Chemical Society in Minneapolis, when Dr. K. F. Bonhoeffer produced twin hydrogen.

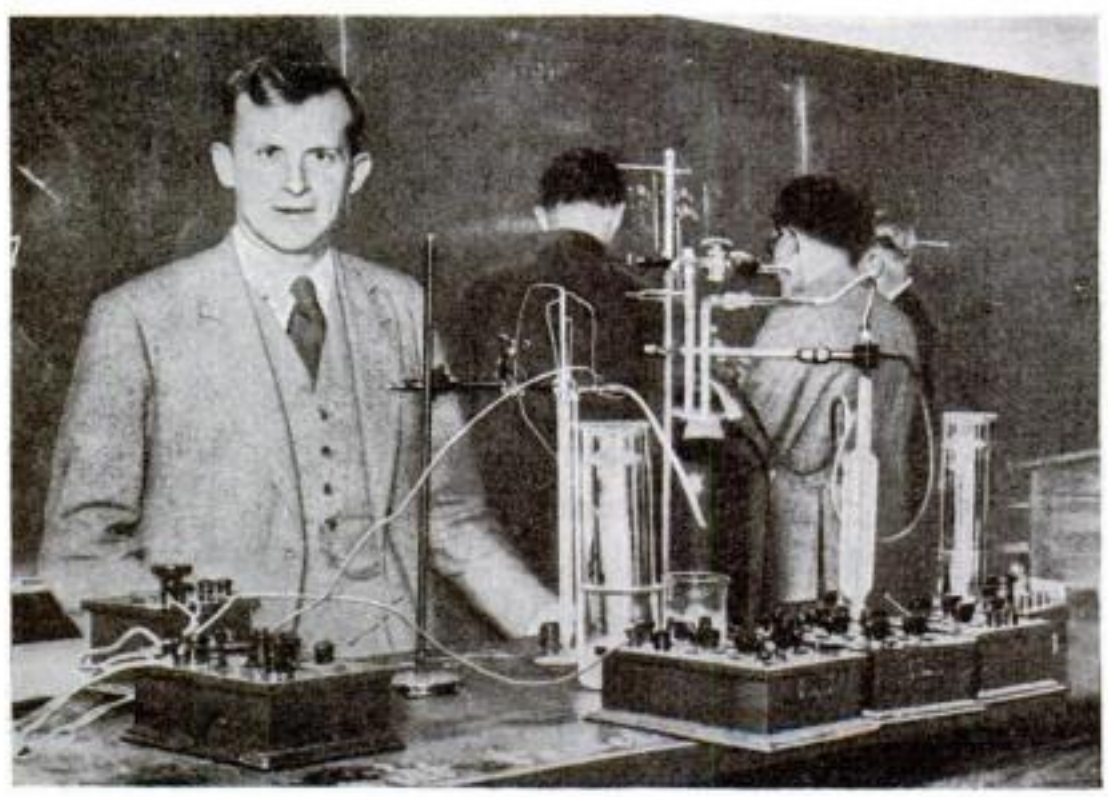
From an ordinary steel cylinder containing compressed hydrogen, Dr. Bonhoeffer drew some gas which he then passed through tubes containing a special form of charcoal cooled to hundreds of degrees below zero by liquid hydrogen. The gas was ordinary hydrogen, containing both of the newly-discovered twins. Out of the apparatus came one twin only, the other one held back by the super-cooled charcoal. The twins look alike, act alike chemically, and are indistinguishable by the majority of ordinary tests. They differ, however, in a few physical properties, including some related to heat. By passing his separated twin over a heated platinum wire, Dr. Bonhoeffer showed that this twin removed heat from the wire at a different rate from that of the other twin or of ordinary mixed hydrogen.

The explanation of why the hydrogen twins differ from each other is based on modern theories of atomic structure. One simple method of regarding atoms is to consider them systems of rapidly moving particles. A familiar model of hydrogen atom is that of a tiny "solar system" at the center of which is a particle called a proton. Revolving around this proton, like a single plant around the sun, is one electron.

It seldom happens that hydrogen atoms exist thus singly. Ordinarily they combine, two by two, to produce what chemists call hydrogen molecules. Dr. Bonhoeffer's twins are twin molecules, not twin atoms.

Full explanation of just how the twins differ from each other would require excursion into modern quantum mechanics and higher mathematics. Approximately, the idea is more simple. Think of the hydrogen atoms each as turning individually, like a cartwheel. Imagine two of these spinning cartwheels attached to each other by a common axle through their hubs. There are two ways, obviously, for this attachment to be made. In one form both cartwheels would spin in the same direction like the wheels of a wagon. In the other form they would spin in the opposite direction. These two possibilities provide the two hydrogen twins. The constituent atoms are believed to be the same. In the two-by-two molecules, one has the same spin on both of its sides, and the other has opposite spins on opposite sides.

The chief interest of Dr. Bonhoeffer's experiment was, undoubtedly, that this difference in the atoms had been predicted in advance by students of theoretical atomic science.



The discoverer of twin hydrogen, Dr. K. F. Bonhoeffer, of Germany, and the apparatus with which he split the supposedly indivisible element into two distinguishable gases.

Filming Human Organs

EXPRESSIONS of the emotions, conventionally depicted on the movie screen by

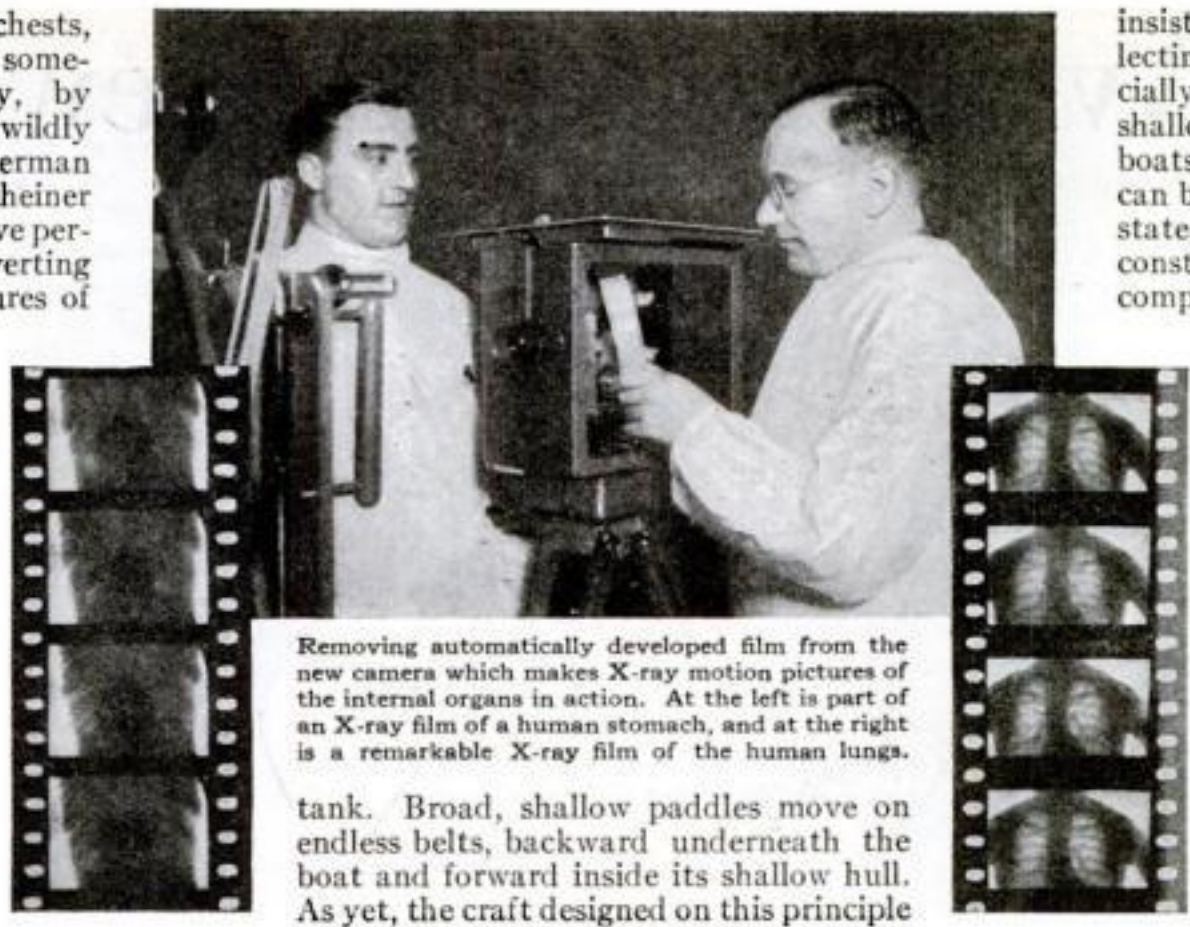
rolling eyes or heaving chests, may now be indicated, somewhat more gruesomely, by actual photographs of wildly beating hearts. Two German experts, Dr. Victor Gotheiner and Kurt Jakobsohn, have perfected a method of converting the familiar X-ray pictures of human internal organs into motion pictures.

The difficulty in accomplishing this has always been the lack of any lens or similar device by which X-rays can be focused. These rays penetrate a lens of ordinary glass just as they penetrate human flesh. A lens of lead glass stops them altogether, still without focusing them. The wave length of the X-rays is so close, indeed, to the spaces which separate individual atoms in glass or other lens-making materials that ordinary photographic methods do not work with X-rays at all. Present X-ray photographs are really shadow pictures.

Several years ago, the distinguished American expert, Dr. Lewis Gregory Cole, prepared X-ray motion pictures of the human stomach in action by combining into a motion picture film separate X-ray shadowgraphs made second by second through a living patient. This method was too laborious for wide use.

Dr. Gotheiner and Jakobsohn have devised a simpler procedure. Placing in front of the patient a special fluoroscopic screen by which the X-ray shadowgraph becomes visible, the German experts then photograph this screen with a motion picture camera, just as though a picture on a movie screen were rephotographed.

The new method is expected to be applicable in many medical and surgical problems; the photography, for example, of the motions of a stomach suffering from spasms or other disorders. Motion pictures of beating hearts are equally possible and may aid the diagnosis of heart disease. Pictures of joints in motion may disclose actions of normal joints as contrasted with those affected by rheumatism, arthritis, and similar disorders.



Removing automatically developed film from the new camera which makes X-ray motion pictures of the internal organs in action. At the left is part of an X-ray film of a human stomach, and at the right is a remarkable X-ray film of the human lungs.

River "Tank" Boats

THE problem of navigating the country's waterways that are too shallow for ordinary transport may be solved by a new "caterpillar boat," which might equally be called a river tank or a floating box car. The device is one of the very few new ideas in water transportation in more than a century.

Developed by the Standard Unit Navigation Company of St. Louis for service on the Cumberland River, in Tennessee, the new power boat consists of little more than a deck, below which is a mechanism not unlike the continuous tread of a wartime tank. Broad, shallow paddles move on endless belts, backward underneath the boat and forward inside its shallow hull. As yet, the craft designed on this principle to serve as towboats on shallow rivers demand a draft of about two feet. Probably the endless tread drive can be modified for still shallower watercourses and for use on cargo craft which are self-propelling.

A system of collection and distribution of freight quite similar to the system used on railways has been devised on the Cumberland River and its tributaries. There is even a radio telephone dispatching system, it is reported, by which the captains of towboats learn where and when to pick up loaded barges, just as the dispatchers issue orders to conductors and engineers of railway trains.

The engineering equipment of the Cumberland River boats, designed by Westinghouse engineers, consists of Diesel engines driving electric dynamos, these dynamos being connected, in turn, to motors which operate the two tracks of treadlike paddles. By operating these two tracks separately, one on each side of the boat, or by varying their speeds, the pilot can steer his craft without a rudder. This Diesel-electric drive, like that used recently on numerous larger vessels, provides a combination of flexibility and efficiency not obtainable, it is claimed, with any other method of power development used for such purposes.

Students of transportation have long insisted that the world is neglecting its waterways, especially waterways which are too shallow for ordinary canal boats. If streams and rivers can be utilized in their natural state, without the expense for construction and upkeep of complicated locks, channels, and other works of canalization needed for ordinary craft, these waterways provide the cheapest transportation routes imaginable.

The curious new Diesel-electric river boat *Sunco-A4* on the Cumberland River, Tennessee. Designed for navigating shallow waters, it is driven by paddles on an endless belt.

A Universal Metal

A METAL harder than a steel knife blade, stronger than the steel wires used for deep-sea soundings, as rustless as gold or platinum, and as light as aluminum not only would be a great boon to modern industrial civilization but is very likely to be supplied. So said Dr. Zay Jeffries, president of the American Society for Steel Treatment, at the recent meeting of that and other metallurgical organizations at Cleveland, Ohio.

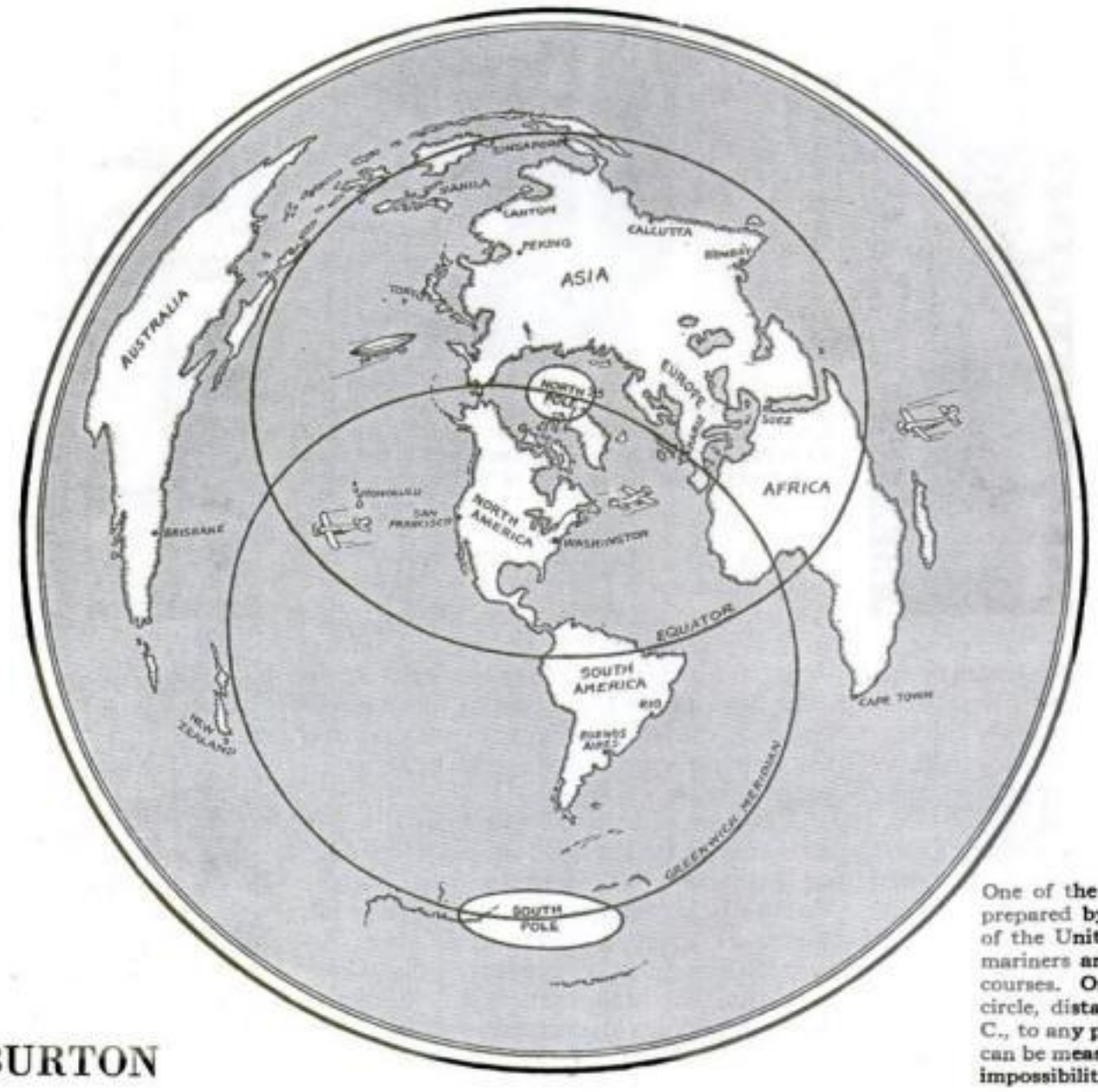
Even now, metallurgists can obtain almost any single property that they want by selecting some metal. Chromium and the new alloy called carballoy are very hard. Vanadium steel and other iron alloys are strong and tough. Tungsten and osmium are exceedingly heavy. Aluminum, magnesium, and the still newer beryllium are (*Continued on page 135*)

How Much Do You Know About Home Heating?

TEST your knowledge with these questions, chosen from hundreds asked by our readers. You will find the correct answers on page 132.

1. **Which is best for heating a home—vacuum vapor, hot water, steam, or hot air?**
2. **How does a mechanical stoker work?**
3. **Which are better, high or low radiators?**
4. **Can a home be heated by electricity?**
5. **How does a one-pipe steam system work?**
6. **If it takes several tons more coal to heat a certain house than it does to heat other similar houses in the same neighborhood, what is the matter?**
7. **Which is better, a round or square boiler?**
8. **When smoke and gas come out of the hot air registers, what is wrong?**
9. **Why is stove size coal more expensive than the smaller or larger sizes?**
10. **Should the fire be banked at night?**

Why Aviation Needs New Maps



One of the new "great circle" maps prepared by the Hydrographic Office of the United States Navy to enable mariners and aviators to chart direct courses. On it the shortest, or great circle, distance from Washington, D. C., to any point on the earth's surface can be measured in a straight line—an impossibility with ordinary maps.

By

WALTER E. BURTON

FOR long-distance voyagers by airplane or airship, the maps similar to those studied in school geographies possess limitations when it comes to plotting courses. Such maps indicate directions, but positions of continents, their shape, and the distance between two points are inaccurate approximations. The earth is, roughly, a sphere, and to find the shortest distance between two points on such a body, "great circle" measurements must be made. In other words, the shortest route is a portion of the largest circle that can be drawn on the sphere, passing through the two points.

The Hydrographic Office of the United States Navy has produced great circle maps that enable mariners to plot their courses with ease. Now similar maps are in demand by aviators. For on them the shortest distance between two points on the globe can be measured in a straight line.

The *Graf Zeppelin* did not fly "around the world." In fact, no true circumnavigation of the earth ever has been accomplished.

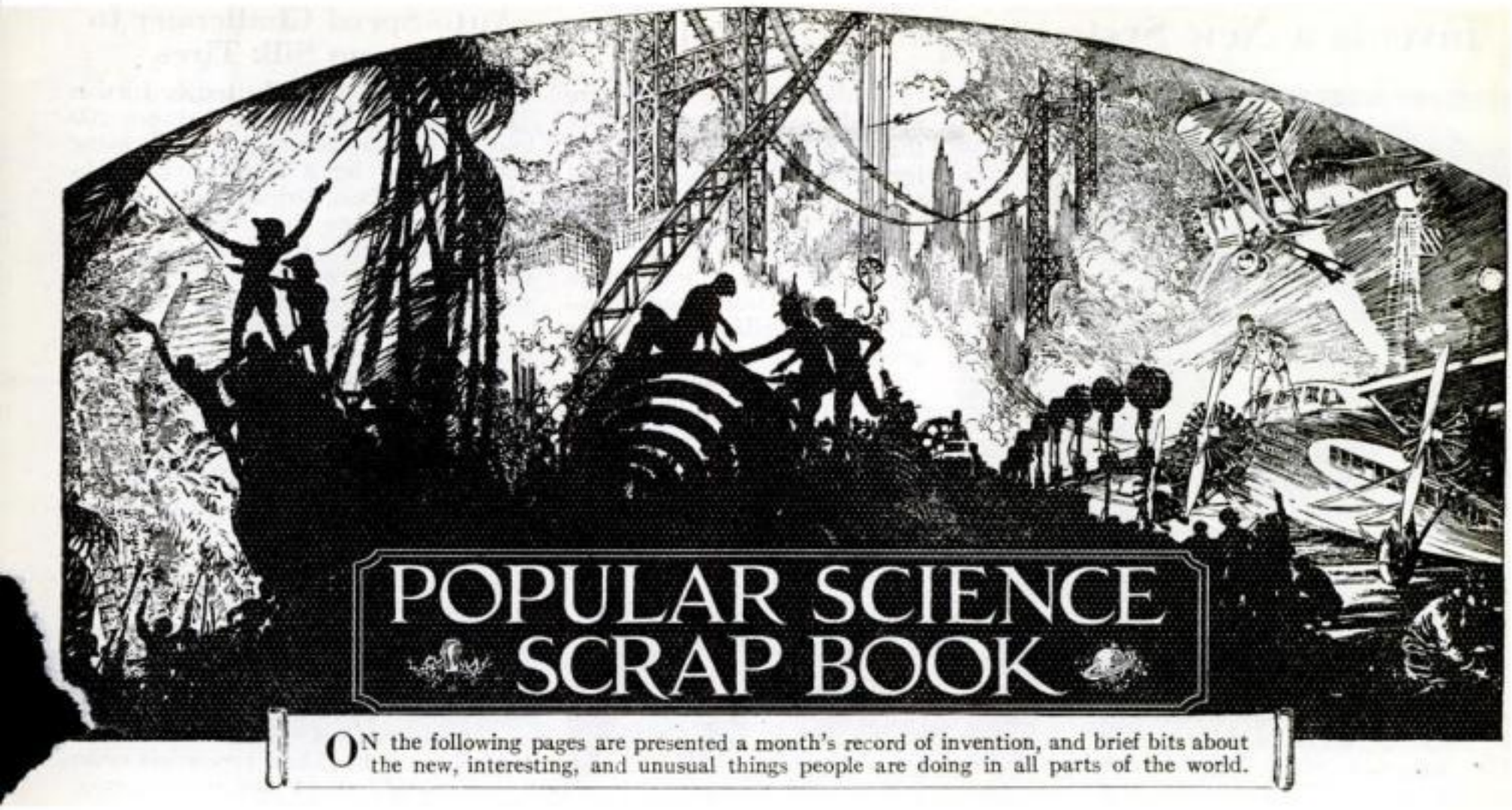
On a small globe map trace the *Graf Zeppelin's* route. It extends from Lakehurst, N. J., to Friedrichshafen, Germany, across Siberia to Tokio, Japan, thence across the North Pacific to Los Angeles, Calif., and on to Lakehurst. What the air liner really did was to fly around the Northern Hemisphere. A true trip around the world must follow a great circle route approximately 25,000 miles long. Every back yard, every point on earth, is on an infinite number of great circle routes. The equator is perhaps the most familiar great circle. Each meridian is another.

The familiar flat maps in common use are called Mercator projections. They are constructed as if the spherical surface of the earth were cut into numerous segments which were ironed out flat and then stretched until all of the spaces were filled in. Sizes and shapes of continents, especially those near the poles, are distorted. Meridians are parallel lines, whereas they really converge at the two poles. The only true great circle line on these maps is the equator.

On the ordinary Mercator maps, the shortest flying route from San Francisco to London would appear to be across the United States to Boston or New York, thence across the Atlantic to the British Isles. But stretch a string between San Francisco and London on a globe, and you will see that actually the shortest or great circle route passes through Montana, goes up through Canada, passing near Winnipeg, crosses Hudson Bay, strikes the southern tip of Greenland, and continues to London. Followed still farther, the route passes near Paris and Rome, crosses Africa, and touches Madagascar.

Stretching a string over a globe map of the world reveals the little-known fact that the shortest route from San Francisco to London and Paris crosses Greenland.

Some day giant air liners will operate on regular schedules between New York and Shanghai, Rio de Janeiro and Sydney, or other far distant points. These liners, instead of following steamship routes, will take the shortest possible courses—over great circles. They will, therefore, travel over the North and South poles, as can be seen by stretching a cord on a globe map between the cities mentioned. For such flying, two-dimensional maps will be useless. Accurate routes can be plotted only on the new three-dimensional maps.



POPULAR SCIENCE SCRAP BOOK

ON the following pages are presented a month's record of invention, and brief bits about the new, interesting, and unusual things people are doing in all parts of the world.

Experts Model Human Organs in Plaster to Aid Study of Medical Science

IN THE old German toy-making town of Sonneberg is a busy shop where expert model makers, descendants of a long line of craftsmen, are turning their skill to the aid of science. There human skeletons, skulls, eyes, ears, limbs, and all other parts of the body are reproduced by the hundreds, to be sold to medical schools in many parts of the world for the study of anatomy.

Done in plaster and strengthened with papier-mâché, the models are either natural size or many times natural size, depending upon the part. A leg or an arm, for instance, is left with normal dimensions, whereas a complex organ like the eye is made about nine inches in diameter.

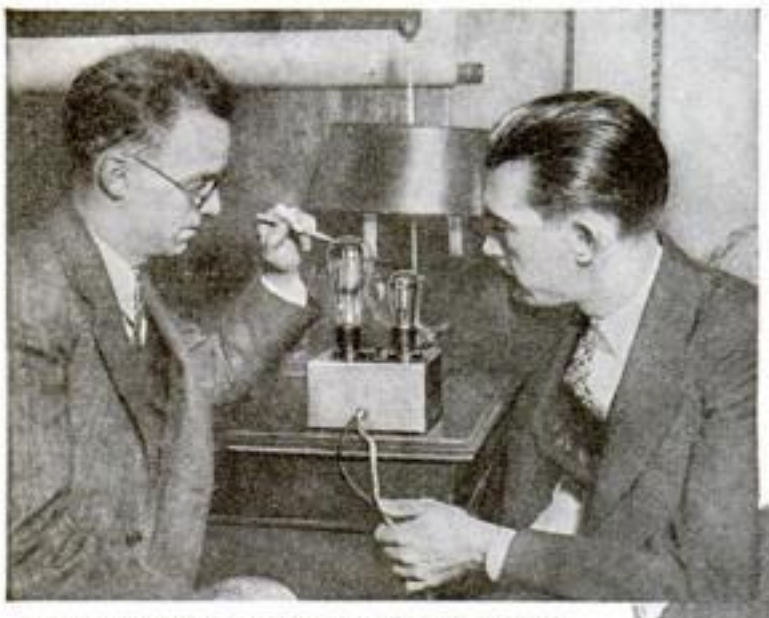
The marvelous accuracy which the shop technicians achieve in producing these models is a vital element of the work, for successful medical training requires the utmost precision in the study of the human organs and the way in which they function.

A table full of model human ears, which include the marvelous mechanism of the inner ear. Though greatly enlarged, every part is reproduced with scientific accuracy. At left: Adding finishing touches to enlarged model of the eye.

An expert craftsman at work on natural sized models of the human skull. They are used by medical schools for the study of anatomy.

Reproducing the abdominal organs in life-size plaster models of the human trunk—a task that calls for extraordinary precision and skill in workmanship.

Invents a New System of Radio Reception



The small power amplifier of the new radio receiver. Dr. Alger S. Riggs, the inventor, is at the right. Three of the special vacuum tubes are shown in the photo at the right.

A GROUP of business men and scientists in New York City recently witnessed a demonstration by Dr. Alger S. Riggs of a system of radio reception which he claims is entirely new. Dr. Riggs declares that special vacuum tubes he has developed, when used in his special circuits, give even better than normal radio reception without making use of many features hitherto thought indispensable.

All the tubes in the radio-frequency and audio amplifier stages of the circuit, he says, work with a positive bias. There is no grid leak nor grid condenser, and the radio-frequency stages are aperiodic—they work without the aid of tuning coils and tuning condensers. Condensers and tuning coils are used in the set, however, in a pre-selector circuit through which the incoming broadcast signals must pass before they reach the radio-frequency amplifier stages of the receiver.

Another important improvement claimed by Dr. Riggs is a true "threshold" detector

arrangement, which, he says, makes it possible to exclude completely static or other electrical interference, provided the signal strength is sufficiently great as compared with the undesirable noise.

Broadcasting Penetrates into Mammoth Cave

SNUGLY lodged in the deep recesses of the Mammoth Cave in Kentucky, with a superheterodyne receiver and loop aerial set up beside them and seventy-five feet of sandstone rock above their heads, Dr. A. S. Eve and Dr. D. A. Keys, of the Department of Physics, McGill University, Montreal, Can., recently listened in on radio programs from Louisville, Nashville, and Cincinnati. They were experimenting to find to what extent radio waves will penetrate rock. With a 300-foot aerial, coupled to the loop of the set, the program was distinguishable through 300 feet of rock.

Similar experiments previously had been conducted in the Mount Royal Tunnel at Montreal. In both the cave and the tunnel it was found that high-frequency stations could not be tuned in, but that low-frequency stations came in loudly. The reception was hardly as strong as that in the open air, however.

Worms Big as Water Pipes

GURGLING like a choked gutter as they retreat into their burrows, monstrous, pipe-sized earthworms from four to six feet long and an inch in diameter are reported to have been discovered by a recent naturalists' expedition in southeastern Australia. They are said to have green eggs from two to three inches long with tough horny shells.

U. S. Army Loans Field for Goddard Rocket Tests

PROF. R. H. GODDARD, Clark University physicist and inventor of a high-altitude rocket, can fire his sky projectiles from Camp Devens, Mass.

Permission to use the field for rocket tests was recently granted by the War Department upon the application of the Smithsonian Institution, which is backing Professor Goddard in his experiments. It is expected that Goddard's next tests will be to extend the range of a high-flying rocket he has developed to soar miles above the earth and bring back weather records by parachute. Not long ago (P. S. M., Oct. '29, p. 24) he fired a nine-foot rocket that flew high over Worcester, Mass., and descended with delicate instruments it contained intact.

Doughnuts Centuries Old

IN CAVES of the prehistoric Basket Maker Indians east of Kenton, Okla., Dr. E. B. Renaud, of the Colorado Museum of Natural History, found food cakes resembling the familiar doughnuts of a modern coffee shop, with the "hole in the center" and all. Cooking vessels and other household implements were unearthed at the same time.

According to Dr. Renaud, these are the relics of a race which inhabited the Southwest before the Pueblos came there. Their doughnuts survived but they perished; is there a moral here?

Auto Speed Challenger to Run on Silk Tires

TO WITHSTAND the terrific friction of traveling at a speed between 200 and 300 miles an hour, silk tires are being manufactured for a new racing car in which Kaye Don, British racing driver, hopes to set a new speed record at Daytona Beach, Fla., this February. The car will have a twenty-four-cylinder engine developing 4,000 horsepower.

The challenger is being built in secret at Wolverhampton, England. Sir Henry Segrave holds the present world record of 231 miles an hour.

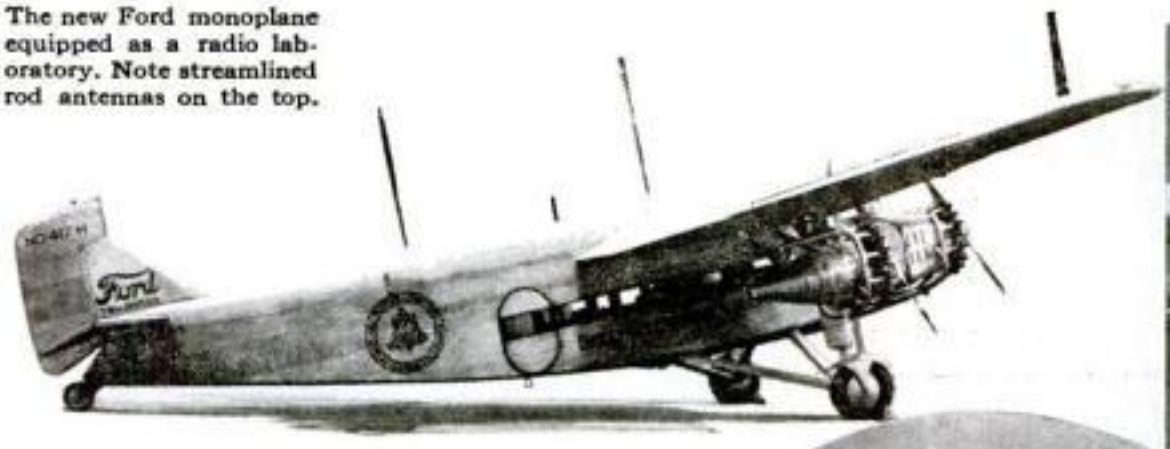
A Wave of the Hand Turns Radio "Howls" into Music

AFTER years of work on an instrument that will produce music when a person waves his hands before it, Prof. Leon Theremin, Russian scientist, recently adapted it to commercial use. It has broadcast music over the radio and is being demonstrated for sale to the public.

The cabinet of the instrument is shaped somewhat like a typewriter cover with a metal upright post at one corner. Within the cabinet, eight vacuum tubes arranged in two oscillating circuits produce a heterodyne beat note similar to those which cause howls from a radio receiver when two or more broadcasting stations interfere with one another. The pitch of the note is controlled by the position of the operator's right hand relative to the metal post. A metal loop antenna is provided at the other side of the device to control the volume. When the left hand is raised or lowered above this antenna, the volume increases or decreases proportionately. The music produced somewhat resembles the tones of a violin or a 'cello.

Playing a tune on the new musical instrument by movements of the hand about a metal post.

Flying Radio Laboratory Develops Airway Telephone



The new Ford monoplane equipped as a radio laboratory. Note streamlined rod antennas on the top.

Operating the plane's apparatus which measures variations in radio signal strength during flight.

Two-way radio communication in the air. At left is a small screen grid receiver, and at right a fifty-watt transmitter.

The midget radio headphone for pilots, designed to fit into the ear channel.

A HUGE "telephone booth on wings" has been added to the equipment of the Bell Telephone Laboratories, of New York City. It is an all-metal, tri-motored Ford monoplane equipped with unique apparatus for testing and improving radio telephone instruments and methods designed for the use of transport and air mail pilots.

In place of seats, the fourteen-passenger cabin contains two long laboratory benches and a wide variety of antennas. On the top of the fuselage, two streamlined vertical rod antennas are mounted. Besides, there are two trailing wire antennas and several wing tip supports for various additional experimental aerials. The metal plane itself acts as a counterpoise ground.

To supply electric current for the mid-air tests, batteries and generators are carried aloft. Some of the generators are run by the engines of the plane and others are wind driven. All metal parts of the machine are bonded, or electrically connected, and all ignition wires and spark plugs are carefully shielded to minimize interference.

An intercommunicating telephone system is one of the unique features of the aerial laboratory. It enables experimenters in different parts of the plane to talk to each other by phone as well as to converse with persons on the ground. Besides testing the latest advance in two-way radio telephone equipment, the plane will be used to measure the strength of radio waves at different altitudes under varying weather conditions and above different kinds of territory.

A midget radio head telephone receiver, said to be the smallest in the world, was used by the pilot of the plane, Capt. A. R. Brooks, in one of the first tests. This tiny instrument is designed to fit into the ear channel, to which it conforms in shape.

A smaller plane, a four-passenger Fairchild cabin monoplane, was previously used by the Bell laboratories in similar experiments. The new machine will allow more extensive tests.

Two-way radio telephone systems have been used on the London-Paris passenger planes for some time and have been adopted by several American transport companies. They allow the pilot to keep in constant touch with the ground and to receive detailed weather reports as he flies. A new lightweight set, which is installed in the tail of a plane, has recently been given successful tests on the Transcontinental Air Transport machines. Conversations are said to have been held with points more than six hundred miles away.

Landlubber Yachtsmen to Sail on a Dry Sea

A "LANDLUBBERS' yacht club," resembling a gigantic, saucer-shaped motordrome, is to be constructed on a dry lake bed covering fifteen square miles of territory near Tonopah, Nevada. Although there is not so much as a pond within one hundred miles of the town, the citizens are undaunted and are going right ahead with their plans for cruising and racing on the dry lake. The actual yachts will ride upon bicycle wheels, but they will have regulation sails. It is said that the lake bed is level and as hard as concrete, while a good breeze may be had at all hours.

Novel Floor Radiator Hugs the Baseboard

WARM floors, better circulation of heat, and an attractive appearance in a room are the chief advantages claimed for a new type of radiator now being made. Long and narrow in shape, the radiator is built so that it may be attached to the baseboard of a wall or recessed, partly or completely, at the floor line of a room. It is eight inches high and three and one half inches deep, and is made in lengths of eighteen or thirty-six inches. Its structure consists of steel fins welded on iron tubing and attached to a solid metal plate at the back of the radiator and to a metal plate along the front. This bracing, according to the manufacturers, safeguards it from leaking, breaking, or bending. Because of its shape and position, the radiator is said to diffuse a mild even heat, and to warm the floors as well as other parts of the room.

Along the baseboard in the background may be seen the new radiator, designed to be more efficient and less unsightly.

Novel Auto Accelerator Has Rotary Pedal

UNIFORM acceleration—the elimination of jerky "pick-up"—and the saving of wear and tear on shoes are advantages claimed for a new "rolling" type of automobile accelerator pedal developed by a Chicago manufacturer as a substitute for the usual button type. It is said to eliminate foot fatigue and thus increase driving comfort.

The rotary accelerator, pictured above, is made of black rubber, fluted, and mounted on a brass bushing, to insure consistent and smooth performance. It is said to respond to the slightest pressure and not to stick or slip. It is adjustable to five different positions and may be used with or without a foot rest.

Musical Scores Composed on a "Typewriter"

"PLAYING the typewriter" will be a new musical accomplishment when composers avail themselves of a machine for writing musical compositions devised by an Italian musician-inventor. The novel "instrument" resembles an ordinary typewriter, but has sixty-four keys instead of the usual forty-two, and a series of buttons and levers controlling machinery that permits the writing of music in any key. A feature is a piece of mechanism like that forming part of linotype machines which "justifies" the lines, ending each with the end of a musical measure.

Brains of Ice Age Men Found in Russia

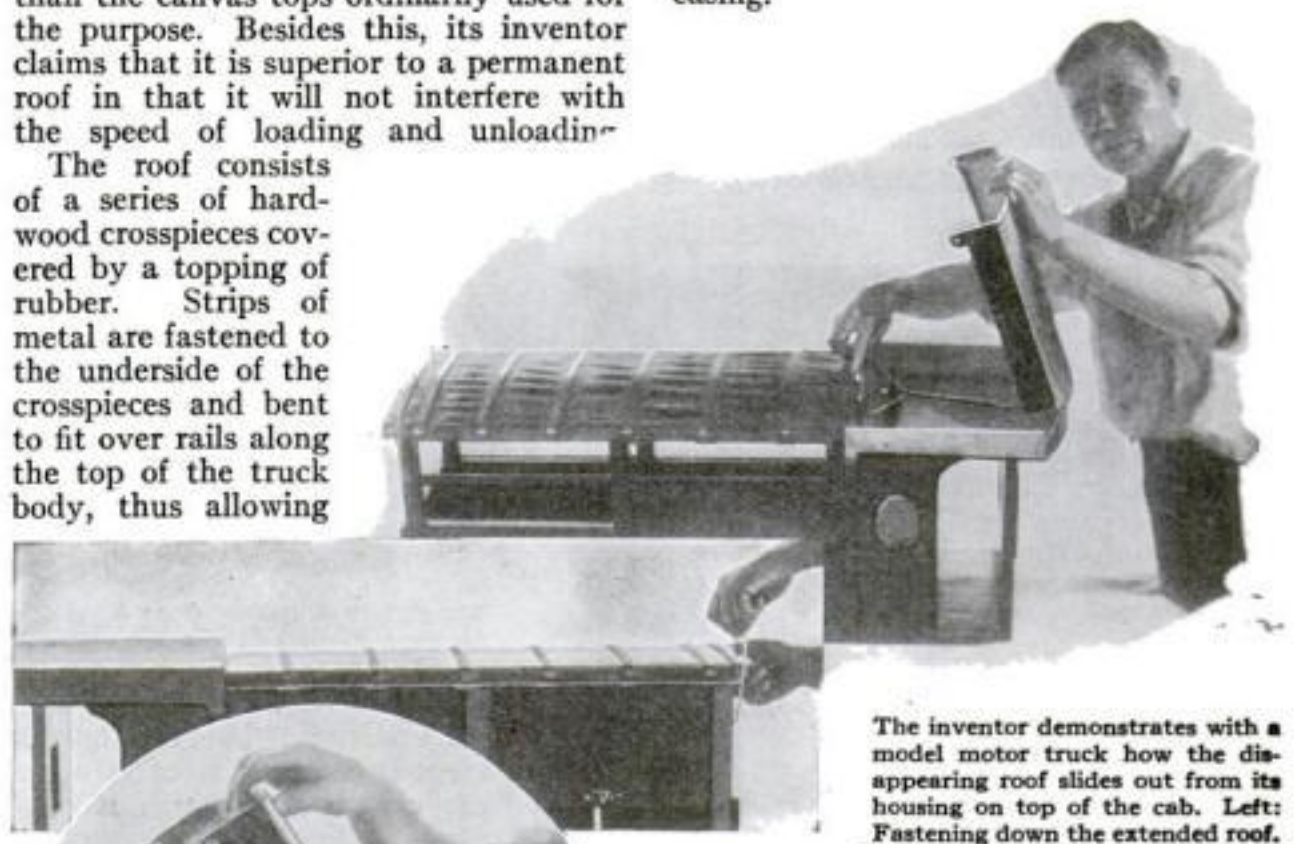
SYMBOLIC of the ancient struggle between the giant beasts that roamed the earth thousands of years ago and prehistoric man, the teeth of a woolly mammoth and two sets of petrified human brains were recently reported found side by side at Odinzowo, Russia.

From a study of the mammoth's teeth the discoverers estimated that the brains date from the Ice Age, at least 12,000 years ago. If their assumption is correct, they are probably the oldest brains ever found. The fossilized brains were found to be only slightly smaller and less developed than those of recent inhabitants of the same section.

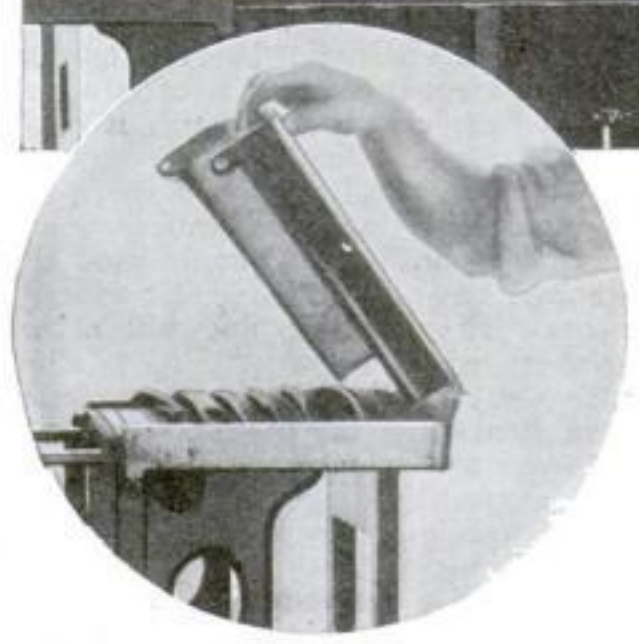
Motor Truck Roof Folds up Like a Screen

A DISAPPEARING rubber roof that slides back and forth along the top of a motor truck, and, when not in use, is folded automatically and housed in a casing above the driver's cab, is the invention of A. G. Schlicher, of Allentown, Pa. He says it will offer surer protection to perishable loads during rainy weather than the canvas tops ordinarily used for the purpose. Besides this, its inventor claims that it is superior to a permanent roof in that it will not interfere with the speed of loading and unloading.

The roof consists of a series of hardwood crosspieces covered by a topping of rubber. Strips of metal are fastened to the underside of the crosspieces and bent to fit over rails along the top of the truck body, thus allowing the roof to slide freely. When the roof is used it is pulled out of the casing to its full length and fastened down at the rear end of the truck. An automatic stop at the front end prevents its being pulled out too far. After the covering is no longer needed it is easily slid toward the front end of the truck and folded neatly in its casing.



The inventor demonstrates with a model motor truck how the disappearing roof slides out from its housing on top of the cab. Left: Fastening down the extended roof.



The cover of the housing raised to show the motor truck top neatly folded and packed.

Dogs and Cats Harbor Dangerous Parasites

THAT rats are infested with fleas which carry bubonic plague and other dangerous diseases is generally known (P. S. M., Nov. '29, p. 46), but few persons are aware that "man's best friend," the dog, plays host to parasites that menace the health of his master.

According to veterinary experts of the United States Department of Agriculture, about 475 different species of parasites inhabit the fur of dogs and cats. Not only are some of these vermin fatal to the animals, but when transferred to human beings may cause deadly diseases, including plague and infantile Kala-azar, a tropical ailment.

The findings of the Department of Agriculture investigators contrast sharply with the experiences of two members of the faculty of Johns Hopkins University, Baltimore, Md., who recently returned from the jungles of Central America, where they conducted a survey of tropical diseases, and reported that they had shot 133 flealess monkeys.

Powdered Coal Increases Steamship's Power

ALMOST twice the power developed by the old-time hand-stoked boilers was generated by one equipped with pulverized coal burners in a test conducted on the steamship *Donau*, of the North German Lloyd, which put in at San Francisco harbor on its maiden voyage from Germany some weeks ago. The steamer has five Scotch marine boilers, four of which are fed by hand while the fifth is fired with pulverized coal. The latter developed 1,800 horsepower, as compared with 1,000 horsepower generated by each of the four others. Powdered fuel burners, it is said, will be installed in three more steamers of the company.

The American freighter *Mercer* was the first vessel to burn pulverized coal on trial voyages in the spring of 1928 (P. S. M., June '28, p. 45).

Magnets Tell Why Famous Speedway Ruins Tires

HASTILY summoned to the Indianapolis Speedway when an automobile tire went flat in a recent nonstop speed test after only a few minutes use, a gang of sixty men, with three lengths of rope to which magnets had been attached, discovered the reason why the brick track, in its seventeen and a half years of use, had acquired the reputation of being hard on tires.

Dragged around the two-and-a-half-mile course, the magnets collected enough tacks, small bolts, and steel slivers to fill three straw hats. These articles had settled in the cracks between the bricks.

Talks to His Scholars Through Loudspeakers

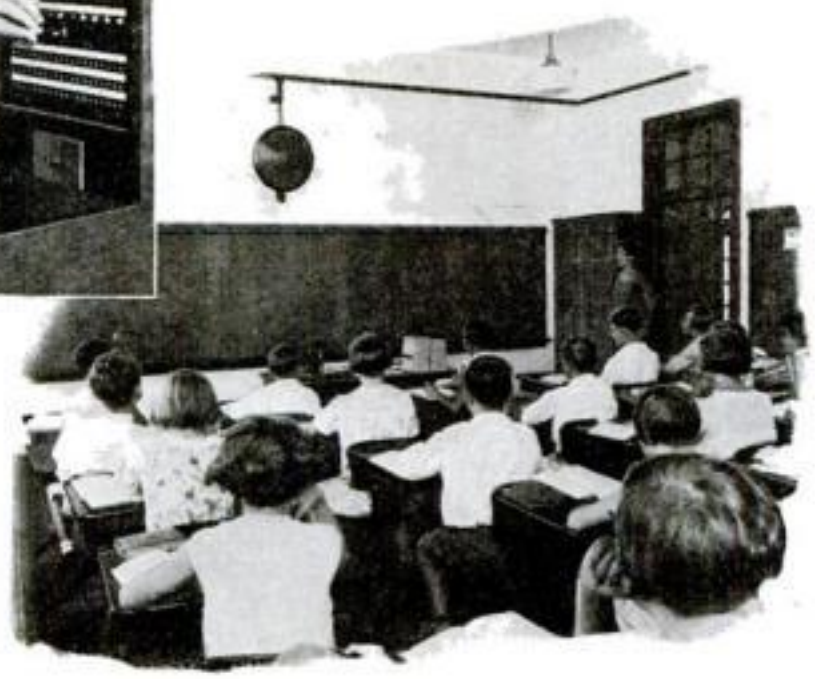
A LOUDSPEAKER in every classroom, bringing to the students important radio programs from a central radio receiver, or, at other times, messages direct from the principal; a cafeteria equipped with speakers that furnish music for the pupils at lunch time; and an auditorium in which the entire school may enjoy such programs in a body—these are innovations in a new $1,500,000 high school at Great Neck, New York.

In the principal's office is an elaborate switchboard that connects directly with loudspeakers throughout the building. Merely by throwing a switch the principal may tune his students in on whatever program he thinks would benefit them. In this way the students can hear important public lectures and symphony concerts.

On the principal's desk is a microphone connected with the switchboard. When he wishes to issue instructions or announcements to classes, he may simply throw another switch and speak through the "mike" directly.

Radio programs are supplemented by phonograph music transmitted along the same wires in the school to the huge loudspeakers in the cafeteria. Thus, when a suitable program may be picked up over the radio, it is used; otherwise the phonograph plays selected music.

Matthew P. Gaffney, principal of the new high school at Great Neck, N. Y., talking through the microphone at the switchboard which enables him to send either radio programs or his own voice to loudspeakers installed in the classrooms throughout the school.



At right: Pupils listening to their principal's voice from a loudspeaker hung from ceiling.

Legs Too Fat? Maybe They're Full of Water

"DE-WATERING" the fat from bulky limbs may be the fashionable procedure in the future for persons whose obesity is of a certain type. According to Prof. Julius Bauer, Viennese physiologist, many women whose legs are too stocky to be beautiful do not have fat legs, but merely watery ones. In the latter case, the water seems to be held in the tissues in a peculiar suspension, as though retained by a chemical sponge.

In order to tell whether a person is troubled with real fat or only the watery kind, Professor Bauer has worked out a method whereby drops of salt solution are injected beneath the skin for a test. A small pimple or wheal is produced. If this vanishes in a few minutes, the fact shows that there is a tendency on the part of the patient's tissue to retain water; hence his fat is not real. Contrarily, if the wheal lasts for an hour or more, the patient is diagnosed as having bona fide fat.

When the individual's type of fat has been determined, it is then possible to go ahead with the proper treatment for his or her condition, which may consist of starving or reducing the water quota, as the case may be.

New Electric Radiators Promise Economy

REPLACING stoves and grate fires still employed to a surprising degree for heating in England, a new electric radiator designed to warm houses and offices at a reasonable cost is being introduced by the City of London Electric Lighting Company. It is claimed that the device can warm a room twenty-four hours for less than fifteen cents, while eliminating tending a fire and removing ashes.

The skeleton of the radiator is a group of metal sheets which are heated to a temperature nearly that of boiling water. The rising warm air is replaced by cold air from below, and a constant circulation of heat and air is maintained. The manufacturers claim their invention uses less electricity than is required by an ordinary heater, as it radiates more heat on wave lengths that are absorbed by air. The ordinary glow-type heater produces much heat that is lost in the walls.

Handy Magnifying Glass Supplies Own Light

CARRYING within its case its own means of illumination, a new electric magnifying glass is designed as a handy aid in reading small print or in examining objects that require fine eyesight. The apparatus is fitted with glass at each of its circular ends. The circular barrel houses a magnifying lens so adjusted that when the device is rested on a newspaper, for example, the lens remains in perfect focus for reading. Within a box-like case at the side of the apparatus is a socket for a concealed electric lamp that supplies indirect lighting without interfering with the visibility through the glass ends. A cord from the device may be plugged into any house socket, and a switch on the side of the barrel permits the user to turn the light on or off at will.

The device, which weighs less than fourteen ounces, is said to have a number of uses. Police departments have employed it to examine fingerprints, and banks may use it to test checks and counterfeit currency. Geologists may avail themselves of it to examine minerals, and jewelers in repairing small watches—in which case the device may be rested on the table, leaving both hands free for working at the repairs.

Detects Counterfeits in Ashes of Banknotes

A SHERLOCK HOLMES of the British detective service in India has laid to his credit the exposure of a banknote counterfeiter by employing the methods of microchemistry. R. M. Ghosal, principal of the Detective Training School at Insein, Burma, was called to investigate the lair uncovered by a police raiding party. A counterfeiter's den had been broken into, but the criminal had time to dispose of his bogus banknotes by burning them.

Removing to his laboratory the charred fragments, Ghosal mounted them between glass plates and studied them. The verdict was that they had been banknotes, but thus far there was no proof that they were spurious. Falling back on much more delicate methods, Ghosal analyzed the ash of the notes, and by comparing their chemical composition with that of the ash of genuine notes, betrayed the counterfeiter's work.

Secrets of Rapid Reading Revealed by Tests

THE fastest reader is one who grasps the meaning of sentences almost entirely by eyesight, without mental pronunciation of the words before him. This is the conclusion of Professor Walter B. Pitkin, of Columbia University, New York, as the result of recent tests.

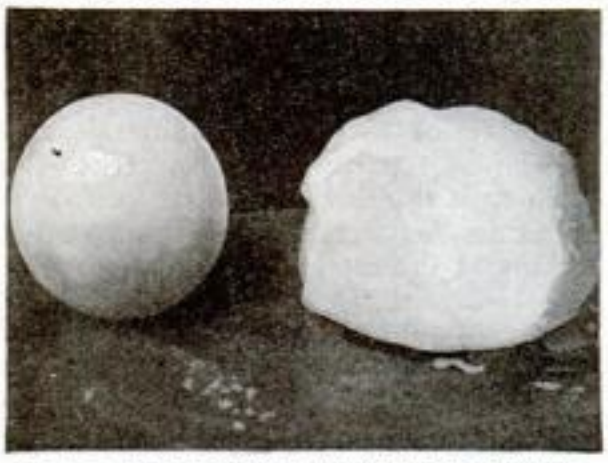
He found that engineers are comparatively slow readers, with an "eye-grasp" of only 3.3 words a second, while experienced editors read 7.2 words a second. But although engineers read slowly, they retain more facts per hundred words than any other group of men.

Most persons mentally pronounce the words they read, declares Professor Pitkin. This is because, as children, they learned to read soon after learning to talk, and the two language functions thus became linked in their minds.

Hailstones Big as Tennis Balls Pelt African City

HAILSTONES larger than tennis balls bombarded Durban, South Africa, during a recent terrific hailstorm, causing damage estimated at $3,750,000. Reliable witnesses in various parts of the world have reported seeing falling hailstones as large and weighing from half a pound to a pound or more, but this is believed to be the first time that one has been photographed. In the illustration, the huge hailstone is compared with a tennis ball, the diameter of which is about two and one half inches.

The stones which fall during ordinary hailstorms measure from one eighth to one half inch in diameter, their size depending upon the violence of the upward



How a large hailstone that fell at Durban, South Africa, compares in size with a tennis ball.

columns of air that produce them. Hail, like rain, is caused by the vertical circulation of the air. Rain is formed by the condensation of drops of moisture in cooling air which grow larger as the air rises until they are heavy enough to fall. Each of the drops rises and falls at least once. Hail, which is frozen rain, is caused by the drops being tossed higher.

In temperate regions such as the United States, a rainstorm turns into a hailstorm when the air columns rise to a height of about two miles and when there is a rapidly rising air current to juggle the freezing drops about at a high altitude, where they accumulate successive layers of snow and ice. As these two conditions seldom occur simultaneously except in summer thunderstorms, hail usually comes with thundershowers, almost always in the summer and seldom at night.

Old Fort Becomes Modern Apartment House

AROUND fortress, built in the early decades of the nineteenth century at Folkestone, on the southeast coast of England, has been converted by an enterprising constructor into a modern apartment house. The fortress is part of the famous Martello towers that were erected to repel a potential French invasion at a time when the name of Napoleon was terrorizing Europe.

This hundred-year-old fortress at Folkestone, England, has been remodeled into an up-to-date apartment dwelling.

There are three apartments in the building, each consisting of five good-sized rooms and a bath. The white color of the curious structure gives to it a cool appearance from the outside, while its shape provides it with ample window space to make that coolness a reality indoors. To add to the comfort of the tenants, garages have been erected at the rear of the tower. The apartments are furnished with all conveniences, including electricity.

Music Visible on Screen Shows Students' Faults

"SIGHT-SINGING," a word used to denote the ability of some vocalists to read from a musical score without previous preparation, may assume a new meaning with the perfection of an instrument that makes musical sounds visible. By means of the novel device, developed by engineers of the Westinghouse Electrical and Manufacturing Company, students of the voice and also of instrumental music may be trained visually as well as orally. The pupil's efforts are picked up by a microphone and the sound waves, amplified and translated into electrical impulses, cause a small mirror to move. This mirror reflects a beam of light upon a second, and revolving, mirror. This, in turn, reflects the light onto a screen, where it appears as a wavy line —a "visible sound wave."

With photographs of sound waves produced by expert musicians as models, the student would be enabled to make comparisons and thus might try to improve the quality of his singing or playing.

Fossil of 12-Foot Hog Found in Nebraska

"BRINGING home the bacon" was no easy task in what is now Nebraska about twelve million years ago, for in that dim day the "cornhusker" state was inhabited by hogs the size of automobiles. The fossil skeleton of one of these gigantic pigs, seven feet tall and twelve feet long, dug up in Sioux County, Neb., was recently mounted at the University of Nebraska. This is one of the only two specimens of the monster ever found.

Pink Oyster Good to Eat, Health Experts Find

"HE WAS a bold man that first eat an oyster," said Dean Swift, author of *Gulliver's Travels*. No courage, however, is required to eat pink oysters, now that the New York State Department of Agriculture has given them a clean bill of health, following an investigation by its bureau of chemistry. Formerly large quantities of pink oysters were discarded because dealers and consumers thought that their color indicated that they were unpalatable and harmful. The New York State chemists found this to be untrue, and pronounced the pink oyster as good to eat as its gray brother.

Visitors at the Bronx Zoo, New York, were recently treated to the sight of a miniature edition of a giraffe, tallest of animals. When seventeen days old, the infant's back was slightly above its mother's knee. Full grown, it will be able to look into a second-story window.

Chair Arms Support Reading-Writing Table

AN ATTACHMENT for an armchair that provides a convenient table for letter writing, eating meals, or card playing and that can be used also as a book rest has recently been put on the market by a Newark, N. J., manufacturer.

The attachment consists of a flat piece of wood hinged to two sidepieces that are strapped to the arms of the chair. The straps may be adjusted to fit arms of varying widths. When it has been placed in position, the device can be raised or lowered to suit the immediate need of the user and rigidly fastened at any one of five different angles.

When used as a desk or table, the board is adjusted to a horizontal position. When converted to a book rack, the angle at which the table is tilted is adjusted to accommodate the eyes or the body position of the reader, and the sidepieces can be slid back and forward along the arms to vary the distance of the board from the user. In any case it is designed to prevent the strain upon back and shoulders which comes from prolonged leaning over a table or a desk.

The appliance is said by the makers to be inexpensive, and is manufactured with various finishes and of different woods to suit individual requirements. It may be used with almost any type of armchair.

The armchair table tilted at an angle to form a rest for a book or magazine. The device is strapped to the arms.

House with Glass Walls Exhibited in Poland

AN UNUSUAL building that formed an interesting feature of an exposition staged recently at Poznan, Poland, suggests how dwellings of the future may appear if men eventually live in glass houses. Apart from a few posts and beams, the structure is almost entirely of glass. Built in an equal-sided L-shape, with a central tower, the house offers maximum sunlight and ventilation.

Since hothouses almost entirely of glass minister admirably to the needs of plants, some health authorities see no reason why glass houses should not be used for human dwellings. In fact, the United States Public Health Service, in 1928, erected a building of which glass was the principal material, in an attempt to determine experimentally how much sunlight should be admitted to a house and how large and of what shape windows should be (P. S. M., July '28, p. 74). A few months ago, a Chicago architect suggested the use of translucent casein as a new material for the walls of houses (P. S. M., Sept. '29, p. 47).

Constructed almost entirely of glass, this L-shaped dwelling was designed to supply plenty of sunlight and air. Exhibited recently in Poland, it was suggested as the possible home of the future.

An Invention to Detect Hit-and-Run Drivers

"PLEASE arrest me" is, in effect, the message conveyed by a new German invention designed to aid the police in capturing "hit-and-run" automobile drivers. The moment a car hits a person or another vehicle, the device, located under the chassis, is said to raise a white plate with a winking red light above the license plate, and also automatically to disconnect and lock the speedometer, thus showing the rate of speed at which the car was traveling at the time of the accident.

The invention, of course, is valueless unless laws compelling its universal use are passed and unless the key is kept by the police to prevent unscrupulous motorists from tampering with the telltale mechanism.

Automatic Switch Turns Out the Lights

WITH a new attachment for electric light sockets, one pull on the chain turns on the light and winds a spring mechanism that automatically turns it off again at the end of a few minutes. The device was designed to eliminate the needless waste of current in cellars, storerooms, and other places where lights are often left burning for hours after they are no longer required.

The attachment fits between lamp socket and bulb and has a spring device wound by the pulling of the light chain. The mechanism, the inventor says, can be set for various periods, ranging from two to ten minutes, and at the end of the time for which it is adjusted will switch off the light.

The names and addresses of the manufacturers of devices which are described on these pages will be supplied to readers on request wherever possible. Address letters to the Information Department, POPULAR SCIENCE MONTHLY, 381 Fourth Ave., New York, N. Y., inclosing a self-addressed stamped envelope for reply.

Useful By-Products from Waste Oil Field Brine

THROUGH the magic of modern chemistry, oil field brine, the waste water which collects near the wells, now is salvaged for use. By a process discovered by Dr. Otto V. Martin, Oklahoma City chemical engineer, valuable by-products are extracted from the brine, including magnesium, used in flashlight powders and fireworks; bromine, used in the manufacture of dyes, medicines, and as a disinfectant; iodine, used in medicines, dyes and in photography; calcium chloride, a drying agent; and others.

The discovery has led to the development of an entirely new industry. Not long ago, Dr. Martin completed at Oklahoma City the second of a chain of manufacturing plants for the extraction of calcium chloride. Eventually, it is planned to establish factories in the vicinity of most of the world's important oil-producing centers. Hitherto, the oil brine has been considered completely valueless and even a nuisance, and in some cases Dr. Martin has been paid for removing it. The cost of production, therefore, is made up only of labor and transportation; no raw materials need be purchased.

Metal Stamp Prints Any One of 12 Characters

AN IMPROVED metal stamp fits into the vest pocket and prints any one of twelve characters. A small wheel set in a steel handle has a fraction line, an X-mark, a cipher, and figures from one to nine embossed on its edge. In using the device, the wheel is turned until the character desired is at the bottom. The wheel is locked in that position and the top of the handle struck with a hammer to indent the number on the metal. The makers point out that the device saves time usually lost in picking up and using different stamps, each embossed with a single number. The rotary stamp comes with interchangeable wheels, permitting the printing of figures of three sizes.

Hinged Life-Saving "Raft" Supports 20 Men

LARGE enough to keep twenty men afloat, yet capable of being packed in a two-by-three-foot space, a new life-saving "raft" was recently tested in the Hudson River at New York City before members of the United States Steamboat Inspection Service. The "raft" is made of short lengths of balsa wood covered with canvas and hinged so that the entire apparatus can be easily folded for storage. Balsa wood is employed because, though quite tough and durable, it is the lightest of all woods, being much more buoyant even than cork, the material generally used in life belts and similar apparatus.

Since 1898, constant efforts have been made to improve life-saving devices for use on vessels. In spite of the fact that of 435 competitors at the Paris Exhibition of 1900 no one had produced a device of sufficient merit to win the Andrew Pollok prize of $20,000 for the best method or device for saving life from shipwreck, many improvements have since been effected in apparatus of this kind. The new flexible "raft," with its qualities of performance and compactness, should add even more to the increasing safety of such devices.

Testing the new life-saving raft made of pieces of canvas-covered balsa wood hinged to fold into a 2-by-3-foot space.

Turns Room Furnishings into Loudspeakers

PILLOWS, photographs, vases, and wall hangings as loudspeakers are the latest thing in radio, developed by E. L. Rice, Washington, D. C., inventor, who has been experimenting to do away with old-style loudspeakers. Rice's ingenious reproducers, which harmonize with other room furnishings and decorations, have been made possible by a new type of loudspeaker unit.

The individual unit, which may be made in many different forms, is said to operate on the condenser principle. In speakers of this type, the vibration is caused by the variations in attraction between two conducting bodies when they are subjected to considerable differences in electrical potential. In Rice's design, layers of conducting and nonconducting paper are subjected to the varying voltage that represents the music or speech at the output of the radio receiver. The nonconducting paper is, of course, made of ordinary pulp fiber, while the conducting sheets are rolled from pulp that has been impregnated with metallic dust.

In the accompanying photograph, six loudspeakers may be located, if one knows their whereabouts. The pyramid-shaped object on the right edge of the cabinet is a cone loudspeaker, and in the inventor's hand is a vest pocket loudspeaker in a leatherette jacket. Six speaker units concealed in the pillow under Rice's head, and others in the vase and photograph easel, allow those articles to project sound. The tapestry on the wall forms one of the largest speakers using the new unit.

Inventor of new loudspeaker unit listening to six different speakers, hidden inside various objects about the room.

Three-Beam Surgical Light Excludes Shadows

A NEW lighting system designed to give shadowless illumination for surgical work of all kinds has been invented by Dr. Leon Lazar, a New York dental surgeon. It has been tested and approved by the United States Navy Department at Washington, D C., and has been adopted by several hospitals and many dentists in New York City.

For dental work the instrument is mounted on a wall bracket or a floor stand, or may be attached to an extension of the dental chair. It includes three independent sources of direct light, each projecting an intense beam. These beams may be converged simultaneously to any focal point by means of a single control handle, which also regulates the horizontal and vertical movements of the instrument as a whole. The three circles of light thus superimposed upon each other illuminate the entire mouth without shadows, while their angle of direction protects the patient's eyes from glare. If one of the beams is obstructed by the dentist's body, the other two would still give shadowless illumination. A daylight filter to convert the intense artificial light to natural light, in which colors appear in their proper values, is a necessary adjunct for matching teeth, porcelain fillings, and the like.

The model intended for use in the operating rooms of hospitals is even more elaborate, involving eight light sources combined in a single ceiling fixture that throws a seventeen-inch arc upon the operating table. The cumulative patch of light thus produced is adjusted by means of a single control handle. General illumination for the operating room is radiated from the same fixture.

Three beams in new surgical light, focused by one control, provide shadowless and glareless illumination for dental work.

Four children can ride on this back-yard merry-go-round, seven feet in diameter. The children operate the plaything themselves by means of four levers which move a mechanism similar to that on a railroad hand car, giving them exercise as well as fun. The apparatus is constructed entirely of metal.

Says Glass Desk Tops Ruin Office Workers' Eyes

THOUSANDS of dollars may be lost by American business men each year because their desk tops and those of their employees are covered with glass, the glitter of which causes eyestrain, resulting in mistakes that prove costly.

This theory was advanced by Dr. E. E. Free, of New York University (Contributing Editor of POPULAR SCIENCE MONTHLY) in a recent lecture given before a group of illuminating engineers at the Westinghouse Lighting Institute, New York City. The pupils of the office workers' eyes, Dr. Free explained, alternately expand and contract in an effort to adjust themselves to the double task of receiving the reflections of bright light-points from the glass desk top and examining less brightly lighted papers at the same time. This condition causes eyestrain, and mistakes and a lowering of general efficiency are the results. Highly polished wooden desk tops are almost as harmful, Dr. Free added. He recommended the use of desks with tops of a nonreflecting material.

On the other hand, Dr. Free said, the same principle might be applied to good advantage by persons who wish to preserve the privacy of their homes without cutting off the air supply by pulling down the window shades. A window framed with a few bright lights pointing outward prevents the curious from inspecting the interior of a room, even if it is normally lighted. This expedient might well be put into use by apartment dwellers in large cities, where windows often look out into courts only ten or twenty feet wide.

Two-Inch Revolver Will Shoot Real Bullets

FITTING into a case so minute that even when fully open it can lie comfortably on the palm of the hand, what is believed to be the world's smallest revolver that will actually shoot is only about two inches long. Some forty years ago this tiny curio and a companion piece were sent over to the United States from England. The one shown here belongs to Miss Elsie Aymar, of New London, N. H., and has been carefully guarded. Its mate, however, cannot be found.

Giraffes Tie Up Telegraph

FREQUENT breaks in African telegraph wires are caused by giraffes running into them, according to a recently returned big-game hunter. The height attained by many giraffes places the wires well within their reach; the tallest specimen ever shot measured nineteen feet.

Radio Held Blameless for Weather Disturbances

RADIO broadcasting has been cleared by Joseph Sanson, French meteorologist and engineer, of the often-heard charge of causing disturbances in the weather. In an exhaustive study of records covering French weather during the last two hundred years, Sanson found that the same atmospheric irregularities that prevail today puzzled the citizens of France long before the Revolution.

As a matter of fact, meteorologists for some years have branded as a popular fallacy the belief that radio affects the weather. The notion became so widespread, however, that scientists deemed it necessary to make an investigation. The fact is that, compared with the enormous quantities of similar electrical energy released constantly into the atmosphere by thunderstorms, the ether vibrations from all the broadcasting stations in the world combined form less than the proverbial drop in the bucket.

But the weather, as all radio fans know, does affect broadcasting. Static, for example, is the voice of certain types of weather. It may be caused by lightning, snow, or rainstorms, and has been traced to advancing heat and cold waves. Sun spots and other solar irregularities also interfere with radio transmission.

Minute Brain Center May Control Man's Weight

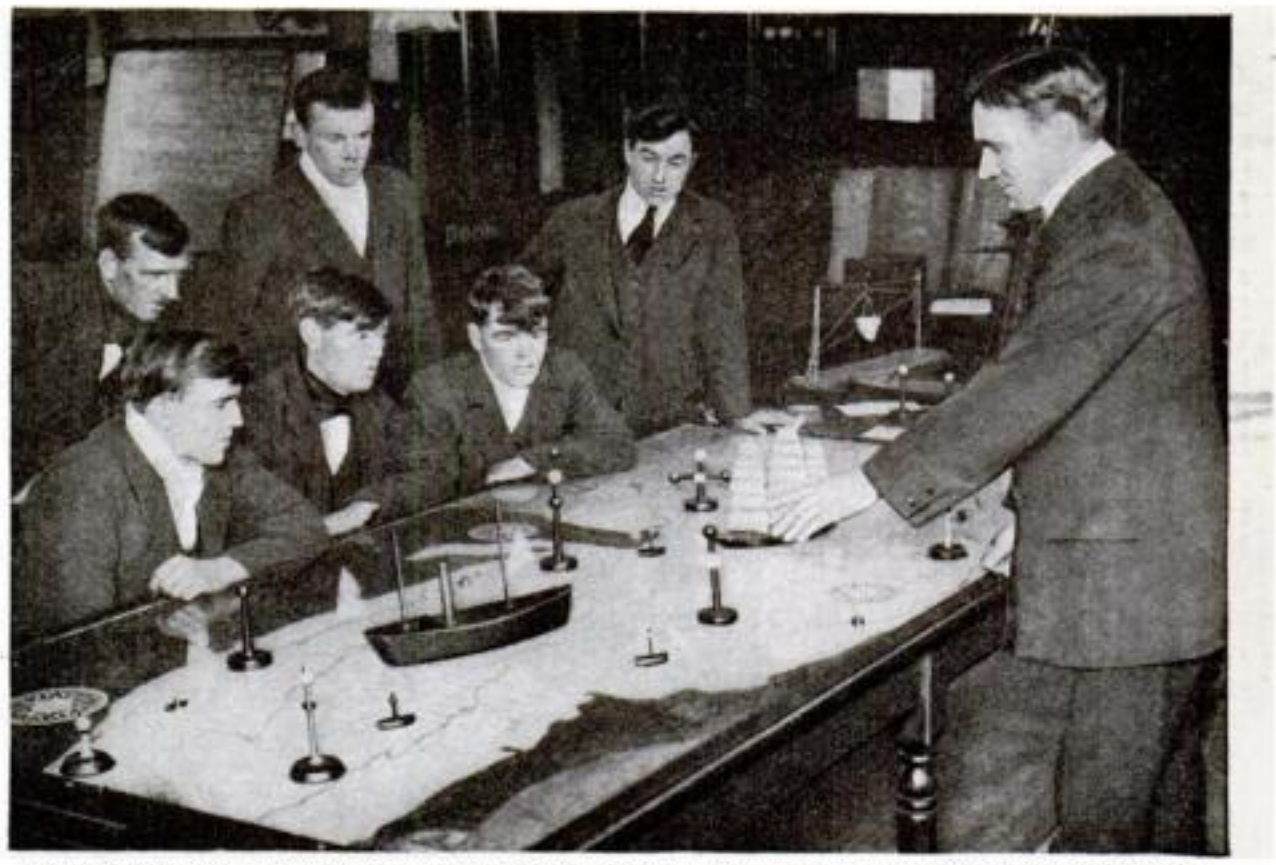
WHETHER a person is destined to be fat or thin may be determined for him from birth, according to the researches of two German physiologists, Professors W. Grunthal and E. Grafe, of Rostock University. They conclude that an infinitesimal button at the base of the brain probably controls one's "basal metabolism," which is really the rate at which an individual expends energy. A thin, nervous person consumes enormous amounts of energy, burning up his food at a terrific rate, while a stout person stores it up in the form of fat. The German scientists say that the tiny brain nucleus apparently is not subject to voluntary control, and hence, if this theory is correct, the ability to regulate weight by the mere exercise of "will power" would be out of the question.

Finds "Left-Eyed" Persons Spell Words Backward

A MAN who writes "ton" when he means "not," and "bat" for "tab," may be "left-eyed," according to Dr. W. F. Dearborn, a psychologist of Harvard University. This is the optical consequence of a natural tendency to be left-handed, he said, and may be expressed in "mirrored" reading or writing. It may be one of the reasons why some backward children cannot learn to read. Other peculiarities, such as writing "framing" for "farming," are associated with a sort of "ambi-dexterity" of the eyes.

A back-hand slant in writing likewise may be a left-handed or left-eyed trait, declares Dr. June Downey, University of Wyoming psychologist.

Fishermen Learn Their Trade in Classroom



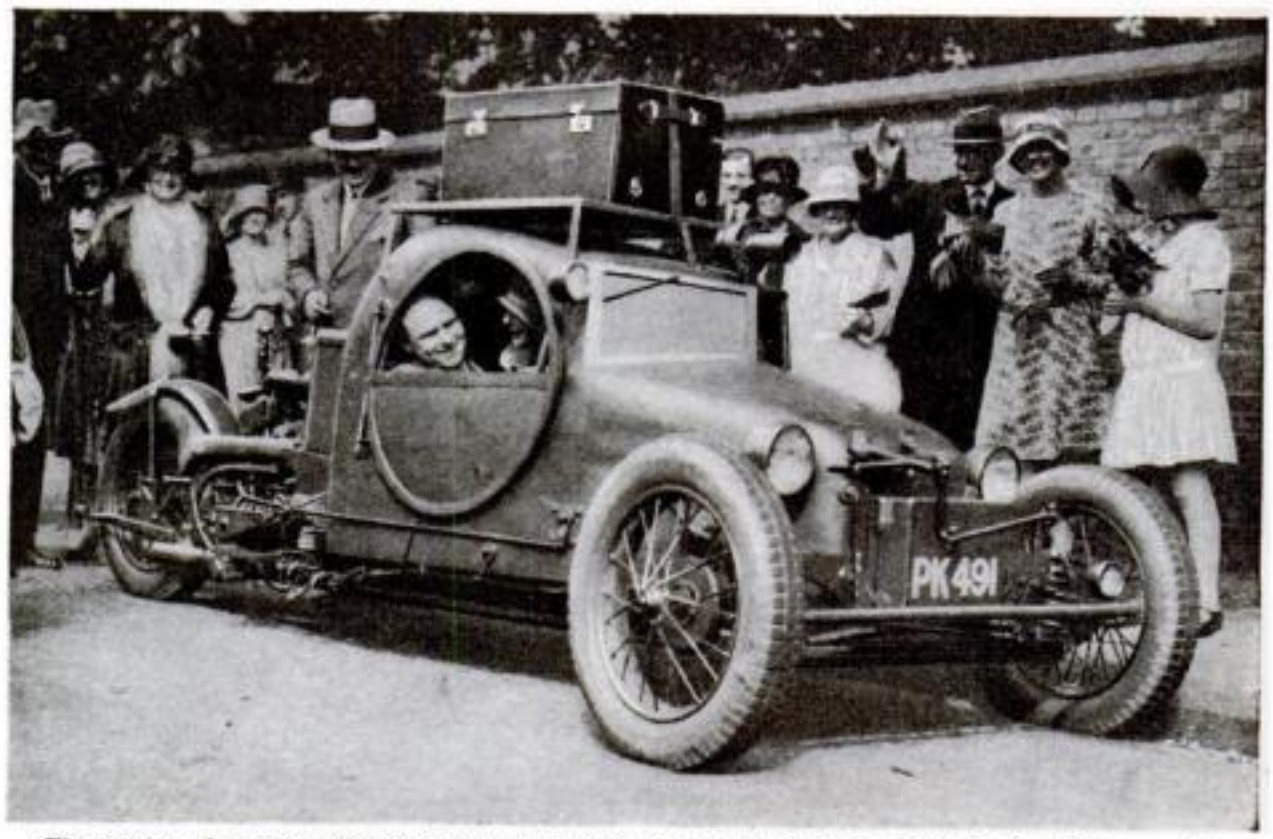
Instructor demonstrating to future fishing ship captains the proper way to navigate into a harbor. Care of nets and rigging of sailing vessels are also taught in this unique school for fishermen.

THE fine points of deep-sea fishing, instead of history or the three "R's," are taught at a school recently established in England. The class meets around a large table, pictured above, the top of which represents a channel and harbor. Toy vessels are navigated among miniature sandbars and past incoming steamers by both the instructor and the students. The purpose of the instruction is to enable the fishermen who attend the school to take out papers as masters of trawlers. Besides training in navigation, the correct use and care of nets and the handling of sailing vessels is taught the future captains of ocean fishing schooners. In the background of the photo is shown a working model of a net and hoist.

Builds Own Honeymoon Car of Queer Design

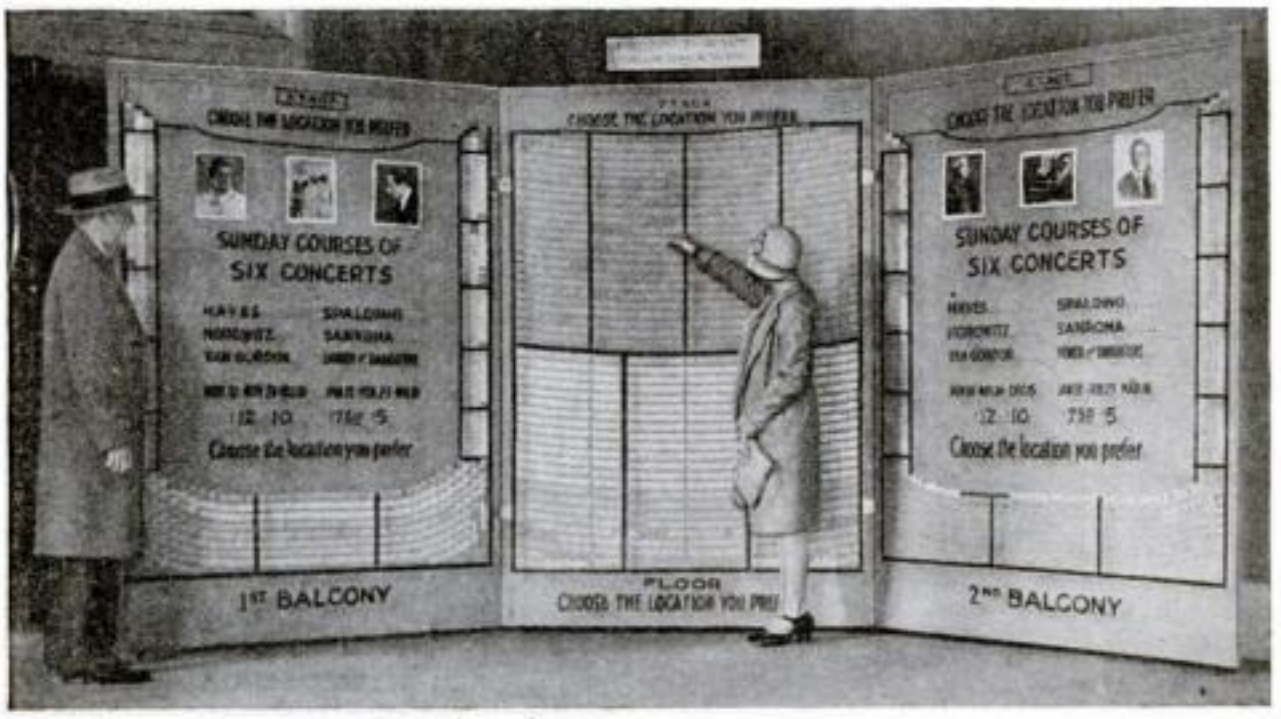
CHEERILY smiling away any possible omens of bad luck that such a beginning might suggest, a resident of Kingston, near London, England, took his bride off on their honeymoon in a curious-shaped three-wheeled vehicle combining in its construction the features of a motorcycle and roadster.

The car, resembling a shoe in appearance, was built by the bridegroom himself to conform to his own ideas of speed and comfort. A platform constructed on top was designed to hold the trunk for the wedding trip. The hood is radically sloped, the motorcycle rear wheel and engine are attached at the rear of the car, and fenders have been stripped from the front wheels and supplanted by a lone mudguard of motorcycle size over the single wheel at the rear.



The newlyweds taking off for their honeymoon in the curious cycle car built by the bridegroom by combining an old roadster and half of a motorcycle. A platform at the top carries the trunk.

Theater Tickets Sold "Cafeteria Style"



The automatic ticket seller at Symphony Hall, Boston, Mass. The patron is reserving her seat by removing a dummy ticket from a slot in the desired location on the rack-diagram of the hall.

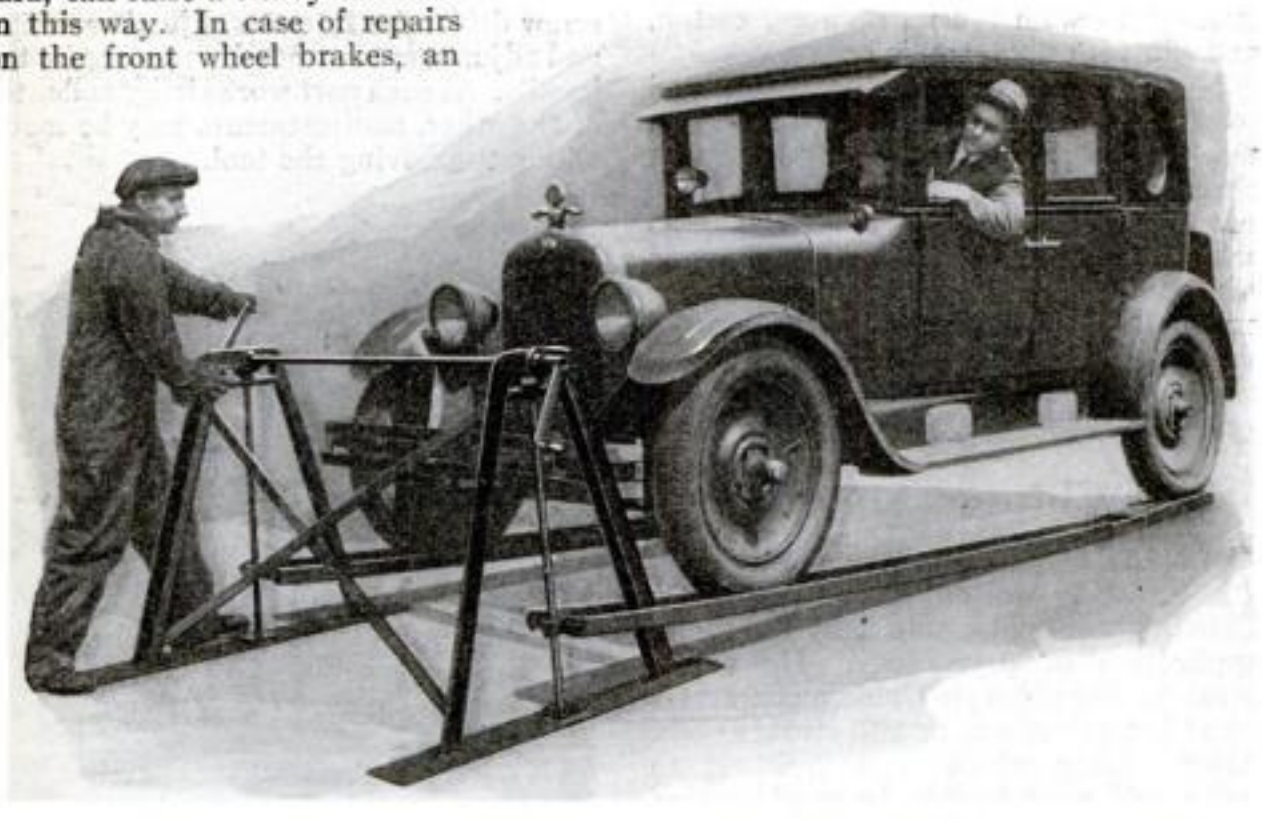
BOX-OFFICE crushes a few minutes before the curtain's rise and the delusions of patrons who think that the ticket agent is "holding out on them" and keeping choice seats for his friends, are two of the nuisances of the average theater lobby that may be eliminated if an automatic ticket selling device recently installed at Symphony Hall, Boston, Mass., is generally adopted.

This invention may best be described as a "ticket cafeteria." It comprises a rack diagramming accurately the location of every seat in the house, with corresponding slots in which dummy tickets are inserted. The customer may thus choose his own seat and "reserve" it by removing the dummy ticket from the slot and presenting it at the box office. The stub of the dummy ticket protruding from the rack resembles a genuine ticket; the hidden part, however, is really an application blank for tickets on which the purchaser inscribes his name and address.

Although this method suits the Boston auditorium's purpose particularly, season tickets being collected and paid for later, with a few modifications the same device might function equally well in other theater ticket offices.

One-Man Jack Raises Car for Work Beneath

A NOVEL auto jack device that so lifts a car into the air as to remove the necessity for mechanics working under the machine in a pit has been invented by C. Emil Liedberg, of Chicago, Illinois. Driven on steel runways, the automobile can be lifted at the forward end through a screw mechanism operated by hand cranks. One man, it is said, can raise a heavy machine in this way. In case of repairs on the front wheel brakes, an adjustment permits the side supports of the jack to be moved closer together, bringing the runways between the wheels and under the front axle. Then when the runways are elevated, the wheels are lifted clear so that they can be turned or removed. The jack can be moved about the garage with little difficulty.



One man lifts the front end of a car with the new portable jack. The car is rolled on runways which are lifted by a screw mechanism operated by a hand crank. The jack is a substitute for repair pits.

New Anesthetic Lessens Fear of Operation

THAT familiar bugbear of surgical patients, taking an anesthetic, may be eliminated in the near future. Dr. J. S. Lundy, of the Mayo Clinic, Rochester, Minn., and Dr. I. M. Isenberger, of the University of Kansas, have collaborated in producing a new anesthetic called "isoamylethyl barbituric acid," which is said to give fewer unpleasant after effects and incur far less danger than many of the local anesthetics now in use.

The occasional bad effects, principally convulsions, of cocaine and its later substitute, procaine, are known. Certain products of barbituric acid were found to give protection against these convulsions. Investigation and experiments with these products were extended until last year Dr. Lundy reported that he had successfully administered the new anesthetic more than a thousand times. It may be given to the patient by mouth, or it may be injected into the veins to produce all or part of a general anesthesia in major operations. It is said not to produce nausea and vomiting.

Produce Motor Fuel from "Wild" Oil Well Gas

BY RUNNING an electrical current through "wild gas," the gas which escapes from oil wells, Professor S. C. Lind and Dr. George Glockler, University of Minnesota chemists, recently produced a substitute motor fuel.

The gas was made to flow through a glass container provided with an inner tube which conducts electricity. When a current at a pressure of 1,800 volts was shot through the gas, motor fuel trickled to the bottom of the container. About one quart of liquid was produced from eighty gallons of the gas.

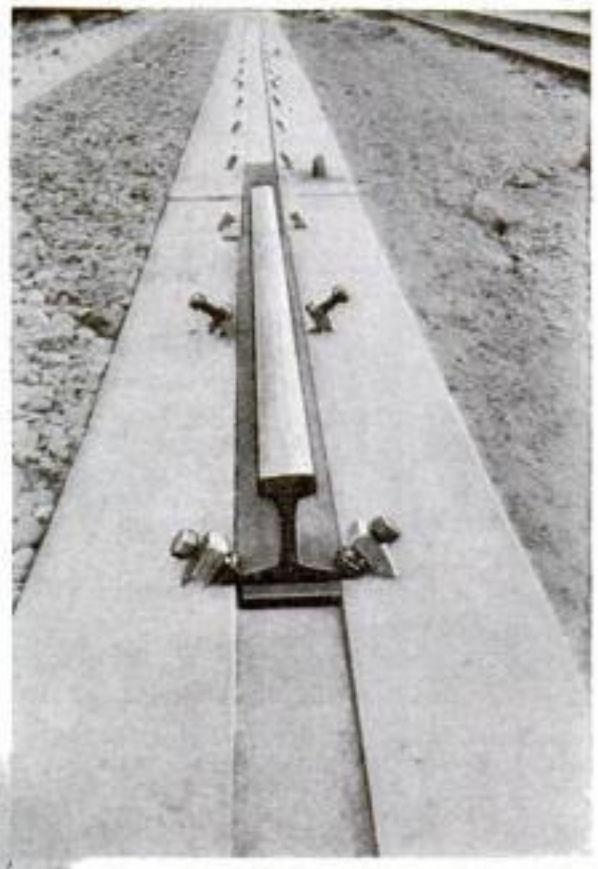
The investigators explained that the test does not pave the way for the manufacture of cheaper gasoline. The new process, however, is another potential weapon in combating any future gasoline famine. Other new methods of producing motor fuel are the hydrogenation process which converts crude oil into 100 percent gasoline by employing hydrogen under high pressure and the similar German procedure of making synthetic gasoline out of soft coal (P.S.M., Sept. '29, p. 48).

Hog-Stomach Extract Used to Treat Anemia

AN EXTRACT made from dried hog-stomach was found by recent experiments at the University of Michigan to be more effective in fighting anemia than liver, used successfully for this purpose during the last few years. The new preparation, said to resemble sawdust and to be tasteless, is so highly concentrated that only an ounce a day will prevent a patient's relapse. This single ounce is declared to equal a pound of fresh liver or about three ounces of liver extract. The experimenters who developed the extract assert that the substance will not cure pernicious anemia, but will relieve the patient's suffering.

A New Railway Roadbed of Concrete Slabs

GREATLY increased speed for railway trains, with smoother and more comfortable riding, is the goal sought by engineers of a newly installed concrete roadbed project at Beech, near Detroit, Mich. The rigidity of the new construction is said to prevent sagging of the rails under the wheels of passing trains, thus offering sixteen percent less tractive resistance than the broken stone wooden tie roadbed in common use for the past seventy-five years. In addition, it will materially reduce costs of upkeep, it is stated. A quarter-mile concrete roadbed installed three years ago has proved its worth, and the present extension of this trial section incorporates many improvements.



A section of the concrete-slab roadbed showing how the rail is fastened by adjustable bolts set at an angle. At left: The roadbed under construction. Note the transverse joint in the foreground.

The new roadbed consists of concrete slabs, each nineteen feet six inches long and nine feet wide and weighing about fifteen tons. Handled by the ordinary crane equipment of a railroad, the slabs may be pre-cast, cured, and transported to their ultimate location. There they are fitted together with tongue-and-groove joints extending their full width.

Girders supporting the rails are cast with the base slabs. At intervals of six feet, transverse girders are placed across the slabs, between the rail girders, the spaces between them being later filled with ballast.

The rail fastenings consist of adjustable two-inch bolts, set at an angle in steel bars embedded in the concrete base slabs. At the bottom of each bolt is a cast shoe slotted to bear against the base of the rail. Precise alignment of the rails is made possible by simple adjustment of the bolts.

Mysterious Paints Change Color at Night

SOME years ago an Englishman, Thomas Griffiths, painted his gatepost white with "a new pigment having a zinc basis." Immediately thereafter the post began to behave peculiarly. Shortly after sunrise the post turned black, but as night fell it became white again.

The behavior of this remarkable post has never been satisfactorily explained, according to Lyman Chalkley, Jr., of the Pennsylvania State College, although today the existence of such peculiar-acting paints and other similar substances has been repeatedly confirmed, and the name "phototropic" has been applied to them. Indeed, the paint manufacturer who supplied the gatepost pigment declared that he already had been familiar with its peculiar property and that it had been causing him considerable trouble. Ever since, the same trouble has dogged the steps of manufacturers of lithopone, a pigment containing sulphide of zinc that is used in paint manufacture. The phenomenon has nothing to do with phosphorescence, another property of certain compounds of this sort.

Today more than two hundred substances are known to be phototropic; that is, they change color when exposed to light and change back again in the dark. Many organic dyes, particularly in liquid solutions, are phototropic. So are certain colors produced with mercury salts in photographic toning processes. A German chemist, H. Stobbe, has found it possible to stain fabrics of wool, cotton, and silk with phototropic colors.

Numerous theories have been suggested to explain phototrophy, but it is unknown today whether its usual cause is a distinct chemical change produced by light in the substance, or whether light changes its color by straining the orbits of electrons within the substance. Whatever the cause, it is known that light waves of short wave length have the strongest effect on phototropic substances.

New Chinese Alphabet?

A NEW Chinese alphabet was the recent proposal of Loh Seng Tsai, of China, who would create it by the direct application of psychology. He would break up the old-style Chinese characters into "letters" of one or two strokes each. After finding which were quickest to write, and most legible, he would assign new phonetic sounds to them and recombine them into new word-characters.

Indian Runners Outpace Horses and Deer

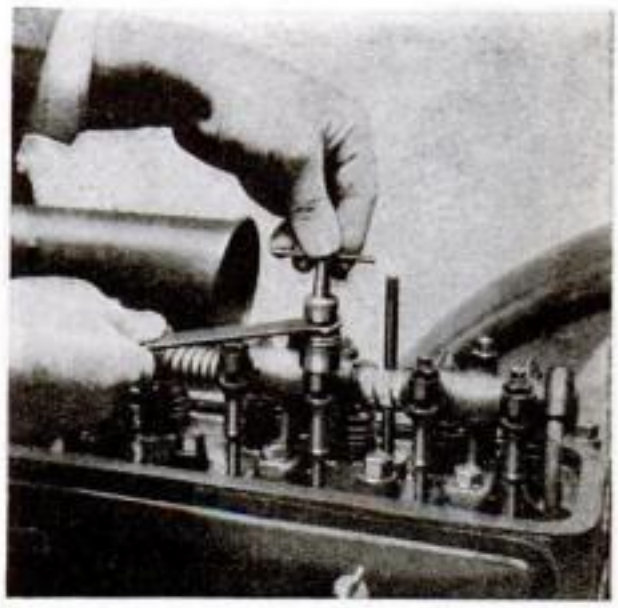
"SWIFTER than a horse" is a phrase that is literally true of the Zuni Indians of the American West, who are often able to outdistance ponies on a long stretch. Their greatest rivals in this respect are the Tarahumare Indians of Mexico, who can outstrip deer in the chase and some of whom have been known to run as far as 170 miles without stopping. The Tarahumares, who boast that their forefathers were the couriers of the Aztec monarchs, are said to be the greatest runners in the world, and the Mexicans, knowing their worth, employ them to run wild horses into the corrals.

Both the Zunis and the Tarahumares lay great stress on races that are conducted on the occasions of important ceremonial rites, such as those during the planting and harvest seasons. The night before a Zuni race, the participants bury various mystic symbols to the incantations of a priest. Before a Tarahumare race, the priest buries human bones along the course to spell doom to the runner unearthing one of them.

At the start of a Zuni race, the runners' heads are bound with bands of cloth. The runners then line up on a diagonal line, the leader of each team standing ahead of his men. On the captain's foot is placed a race stick, about as thick as a finger and long enough to cover the base of his toes. At the signal to start, he tosses the stick as far ahead as he can; the runners dash for it, and the first man to reach it kicks it ahead to continue the race. The Tarahumares use a ball.

Combination Tool Adjusts Auto Valve Tappets

ADJUSTMENT of tappets on overhead valves is made a quick and easy process, it is said, by means of a new tool specially manufactured for this purpose in Cleveland, Ohio. The tool consists of a socket wrench and a screw driver, the latter being inserted through the hollow stem of the socket. The wrench is for loosening the locking nut, and removable, interchangeable sockets can be used. The screw driver fits into the adjusting screw, and adjustment is made by turning its tee handle. As each part works independently of the other, readjustments may be made without removing the tool.



Adjusting overhead valve tappet with new tool combining socket wrench and screw driver.

Giant "Hand" Tows Ocean Liners into Berth

REACHING out like a colossal guiding hand, a huge curved spring girder grasps the bows of great ocean liners entering the new Tilbury docks, near London, England, and pulls them into the berth, where hydraulic bilge blocks rise from the bottom and grip their keels.

As a result of the recent opening of the new docks, which took twelve years and $70,000,000 to construct, the largest vessels now can berth only twenty-six miles from the British capital.

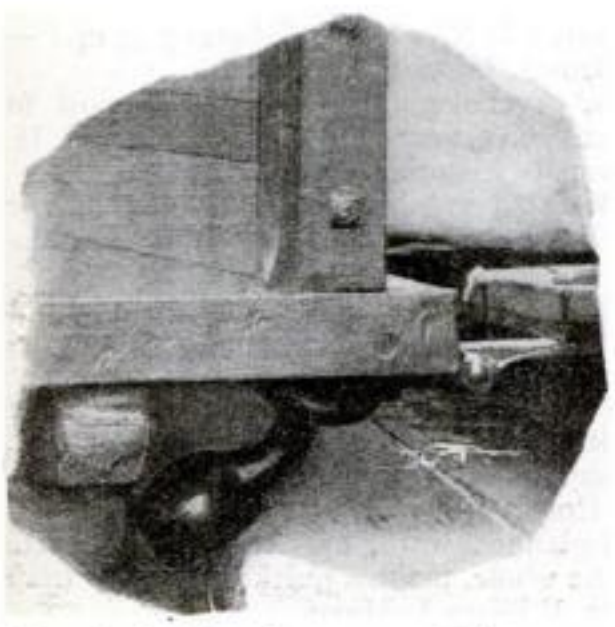
An idea of the proportions of the development may be gained from the fact that the entrance channel is 1,000 feet long, 110 feet wide, and forty-five and a half feet deep at high water, and contains a huge lock, consisting of two parts, one 700 feet and the other 300 feet long. Hydraulic sluices fill or empty this enormous lock in only ten minutes.

The dock proper is connected with a dry dock 750 feet long, 110 feet wide, and thirty seven and one half feet deep at high tide. A passenger landing stage, resting upon sixty-three massive steel pontoons and costing $1,800,000, completes the chief features of the structure. The old Tilbury docks were opened in 1886. Their area was extended to ninety acres in 1917, when work on the present improvements was begun.

Rubber Tail Lamp for Trucks Unbreakable

TWISTING or bending instead of breaking off when it comes into contact with a curb or other obstruction, a new flexible rubber tail lamp for motor trucks is designed to save repair bills and to avoid court summonses for defective lighting gear, according to its maker.

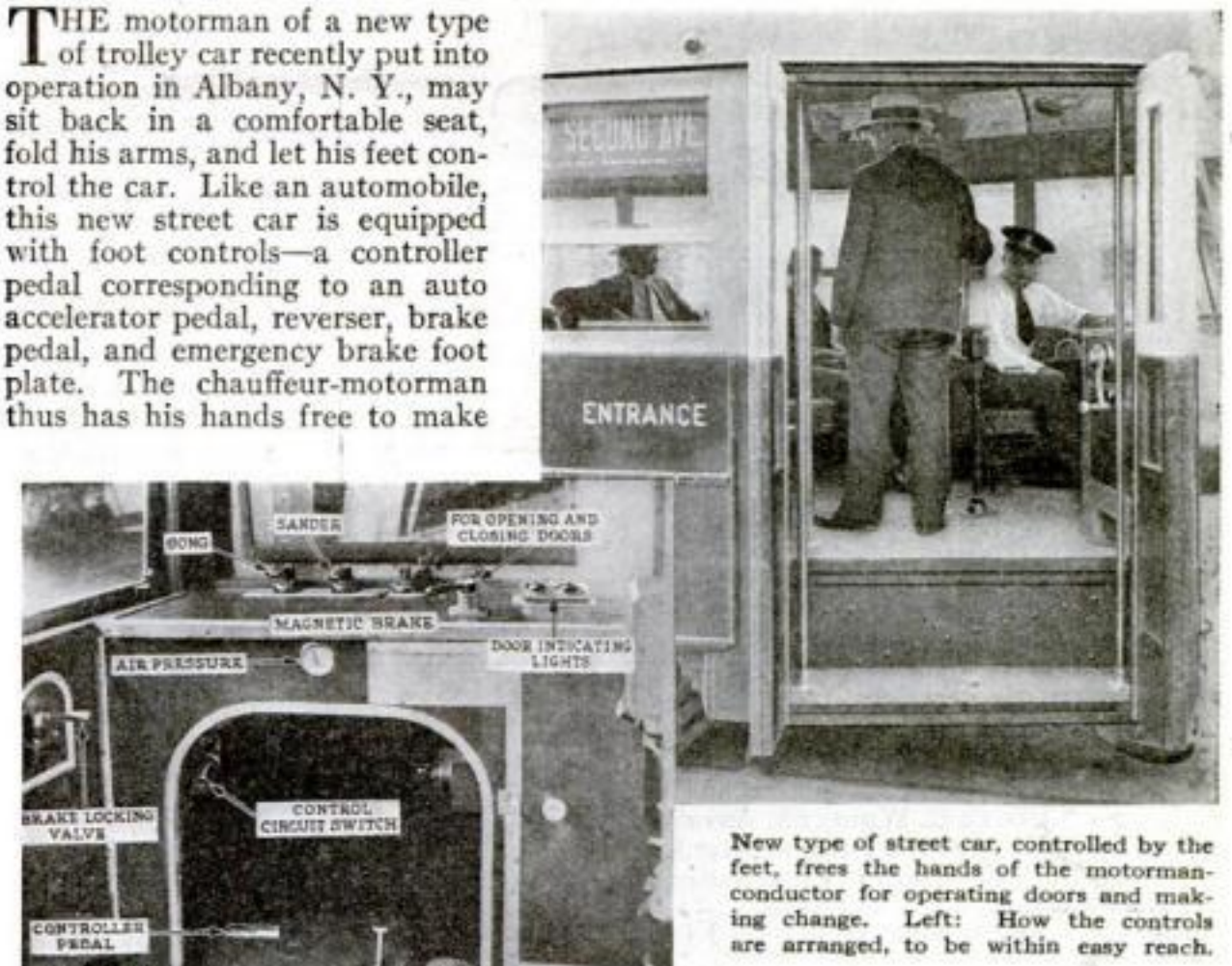
The lamp itself is made entirely of rubber and is fitted with an especially bright lens. The electric bulb is suspended by rubber in the lamp, and is cushioned by a light spring, so that it will not be readily affected by vibration—often the cause of damage to the ordinary tail lights used on trucks. The lamp is fastened to the truck body by an iron holder, and is so fitted that it has freedom to bend at will, it is said, without any danger of being broken or sheared off.



How the flexible rubber support of the motor truck tail lamp bends when it strikes a curb.

Novel Street Car Operated Like Automobile

THE motorman of a new type of trolley car recently put into operation in Albany, N. Y., may sit back in a comfortable seat, fold his arms, and let his feet control the car. Like an automobile, this new street car is equipped with foot controls—a controller pedal corresponding to an auto accelerator pedal, reverser, brake pedal, and emergency brake foot plate. The chauffeur-motorman thus has his hands free to make change or operate other controls for sounding the gong, opening and closing the doors, and sanding the tracks. This method of control is said to permit speedier handling of the car and to increase the safety and comfort of passengers.



New type of street car, controlled by the feet, frees the hands of the motorman-conductor for operating doors and making change. Left: How the controls are arranged, to be within easy reach.

Psychologists to Study Gorillas in Africa

AN ATTEMPT to come in close contact with the gorilla in its native haunts will be made by Dr. Harold C. Bingham in an expedition sponsored by the Institute of Psychology at Yale University. Accompanied by his wife, Dr. Bingham plans to spend the greater part of a year in the Belgian Congo seeking answers to the many mysteries concerning the mental capacity and habits of the largest of the manlike apes.

Dr. Bingham has spent the last four years in a study of chimpanzees, and he has contributed greatly to man's knowledge of this group of the ape family. There are only two regions of Africa where the gorilla is to be found. One lies on the West Coast and extends from the Cameroon to the Belgian Congo. The other is far to the east, in the Kivu district of the Belgian Congo. It is in this latter region that the Bingham expedition is to conduct its study.

Here the gorillas enjoy all the seclusion of a private estate of some 700 square miles. And they have that private estate because of the efforts of the late Carl Akeley, famous explorer and taxidermist of the American Museum of Natural History in New York. It grew out of an expedition which he headed in 1921 to obtain specimens for a great African Hall in the American Museum. On his return he called this district to the attention of the scientific world as the most beautiful and magnificent part of all Africa. But Akeley warned the Belgian government that unless immediate steps toward conservation were taken the gorilla would soon become extinct. As a result King Albert created the huge sanctuary known as "Parc National Albert," where no animal life may be taken and no vegetation disturbed.

Akeley went back to this district in 1926 on a second expedition from which he never returned. Contracting fever on the way through the jungle, he died a few days after reaching his former camp and was buried in the district he had helped to make possible as a storehouse of knowledge for future investigators.

THE present expedition to the Kivu region will not secure any specimens unless it becomes absolutely necessary in order to save human life. But Dr. Bingham expects to get just as close to a tribal group as he can, and to stay there just as long as the gorillas will permit him. That might not seem a very difficult task, but the gorilla resents any attempt to observe the daily routine of his life. Most animals can be approached while asleep and then observed from a vantage point after they awake. The gorilla, however, may be snoring in deep sleep when the slightest rustle will send him charging off through the forest. Although comparatively mild when undisturbed, if wounded or surrounded the gorilla becomes the most ferocious of animals.

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Noise — A Spur to Invention

COMPLAINTS against noise are probably as old as is noise itself. From time to time, as at present, such protests organize themselves into a concerted attack on the universal menace. In New York City, and in London, England, doctors, psychologists, industrial experts, and others have organized to investigate the harmful effects of noise with a view to striking at the roots of the nuisance. The most important aspects of this lively topic are discussed elsewhere in this issue.

In an age when mechanical inventions follow on each other's heels, a corresponding increase in volume and kinds of noise might be regarded as inevitable if industry is to continue its progress. That, however, need not necessarily be true. Only last month, for example, we told how the noiseless process of welding seems likely to supplant the terrific din of riveting in building construction and in industrial plants. Again, soundproof cabins have made the airplane virtually soundless to its passengers. But progress even in these two fields need not stop here. The airplane also must be made noiseless to people on the ground below; and welding may become but one small item in the development of comparatively silent construction.

Present tendencies indicate great opportunities for further successes in the war against noise. Instead of acting as a curb on the productiveness of inventors, the campaign points the way to a fresh field of operation where some of them, at least, will direct their attention to producing inventions to eliminate, rather than create, noise.

"What's New, Professor?"

IN A note accompanying his summary of the year's achievements in astronomy, published in this issue, Prof. Heber D. Curtis, Director of the Alleghany Observatory at Pittsburgh, Pa., took a sly poke at the layman's insatiable quest for thrills.

"Next to questions regarding the habitability of Mars," said this eminent astronomer, "there is doubtless no query more embarrassing to the professional astronomer than the all too frequent demand of the layman for information as to 'what he has been discovering lately.' Astronomical programs of research, he pointed out, are planned for decades rather than months, and great discoveries are the result of the patient accumulation of minor observations.

This is not the first time Prof. Curtis has had occasion to deprecate sensation. Once before, when he was pestered by telephone calls and requests for interviews as a result of spectacular meteor-shower predictions in the press—predictions which, of course, never materialized on the grandiose scale expected—he uttered another broadside.

"In a somewhat extended experience," he is quoted as saying, "I have met perhaps five gentlemen of the press who were exceptions to the general rule that a reporter is a brilliant young man whose mission in life is to improve the truth."

Whether or not that rather sweeping indictment was justified, Prof. Curtis' present point is well taken. Lick Observatory, he himself points out, has devoted more than thirty years to measuring star speeds from their spectrums. Mt. Wilson Observatory has worked nearly as long on certain definite solar and stellar problems. His own observatory has labored for fifteen years on star distances, with, he says, at least fifteen more years still to go. In such a program, a year that is marked by several items such as "the investigation of some maverick star" or the explanation of some "hitherto unexplained spectral lines" is a year of progress indeed.

Ancient Glories in America

COLONEL LINDBERGH'S recent discovery of four ruined Mayan cities, three of which are believed to be "new," has served to focus public attention once more upon a complex and splendid civilization that began to develop in Central America at a time when the British Isles were still a wilderness and attained its full florescence when the European continent was overrun by the semi-barbaric hordes of Charlemagne. In archeological circles, it has revived the hope that the key to the mystery of the origin of the Mayan race and its culture, which was lost when the Spanish conquistadores destroyed most of its records and a multitude of its marvelous works of art and learning, may be found at last.

At present, there is some doubt as to whether this hope will ever be realized. It would take many months, and perhaps years, of arduous work in dense tropical jungles to explore the cities Lindbergh located from the air, and such expeditions cannot be undertaken without substantial financial support. Unfortunately, this is almost wholly lacking. While vast sums are contributed by wealthy American patrons of the arts and sciences for archeological exploration in far-away Asia and Africa, little money is available for similar effort on our own continent.

This strange situation is all the more surprising because the history of ancient Americans would seem to present a problem at least as fascinating from the American point of view as those of the ancient Mongolians or Egyptians. It is partly due to a lack of interest caused, perhaps, by a system of education which emphasizes "the glory that was Greece and the grandeur that was Rome," but fails to stress the magnificence that was Maya. But not entirely.

International rivalry, it seems, is the chief stumbling block in the way of energetic attempts to solve the Mayan riddle on the part of scientific societies and their backers in the United States. According to students of the subject, the Mexican people, jealous of the treasures which they consider part of their racial and cultural history, have not given American investigators the co-operation necessary to effect a solution of the great Mayan mystery.

They Are Saying —

"WHEN stocks go down in New York, diabetes goes up."—Dr. Walter L. Brown, London physician.

"Next to economics, psychology has contributed most to history in the last twenty-five years."—Prof. Carleton J. H. Hayes, Columbia University historian.

"As an instrument of death and destruction, the automobile is without a rival."—E. Sullivan, New Hampshire Commissioner of Insurance.

"There is not an airplane flying today that will not be out of date and obsolete in two years."—William B. Stout, designer of Ford Metal planes.

"Breathlessness and pain in the left chest, rarely mean heart disease in young adults. In fact, the patients with organic heart disease rarely complain of these symptoms."—Dr. M. A. Rothschild, Mt. Sinai Hospital, New York City.

"Patients in a well-planned ward, even with a moderate degree of privacy, on the whole, make a quicker recovery than in private rooms."—Dr. William J. Mayo.

"In the use of electricity, the American home is lagging behind industry."—Matthew S. Sloan, New York Edison Co.

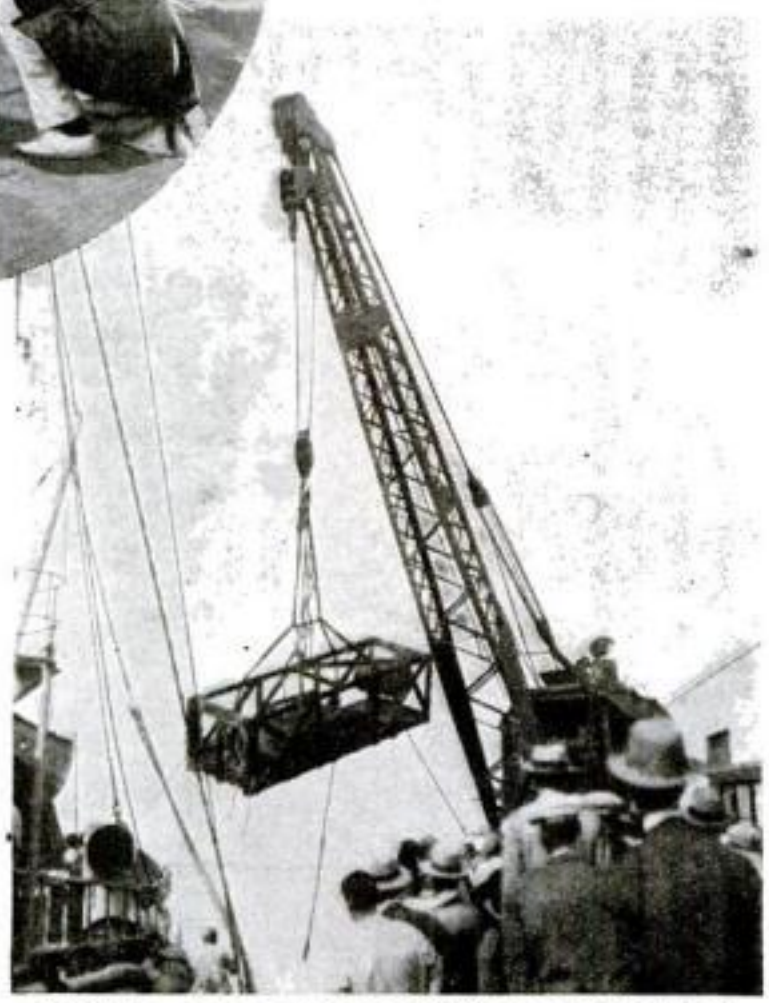
Rare Sea Elephants Saved for Zoo

By H. H. DUNN

Teasing an old bull elephant seal. Though slow in movement, the great animals are fearless and belligerent.

SAVED from the extinction which threatens their dwindling herd, four elephant seals, the only ones of their kind in captivity, were carried to the San Diego zoological garden a few weeks ago from the Mexican island of Guadalupe, 250 miles to the south. These are the northern elephant seals, known as "sea elephants." About 300 of them on Guadalupe Island are all that remain of the thousands that once flourished along the Pacific coast from San Francisco to the equator.

The United States Coast Guard, the San Diego Zoological Society, and the San Diego Natural History Museum combined in this expedition to save for posterity a breeding stock of the huge mammals. Two bulls, one weighing 5,000 pounds and the other 3,000, with two cows of about 1,200 pounds each, were caught by the expedition, directed by Dr. H. M. Wegeforth, president of the Zoological Society. A larger bull was lost in the surf when the bottom fell out of the cage in which it was being transported to the ship. Dr. Wegeforth estimates the weight of the "one that got away" at 7,000 pounds.



Hoisting a crate containing a 5,000-pound elephant seal from the tug *Koka* to a waiting truck at San Diego, Calif.

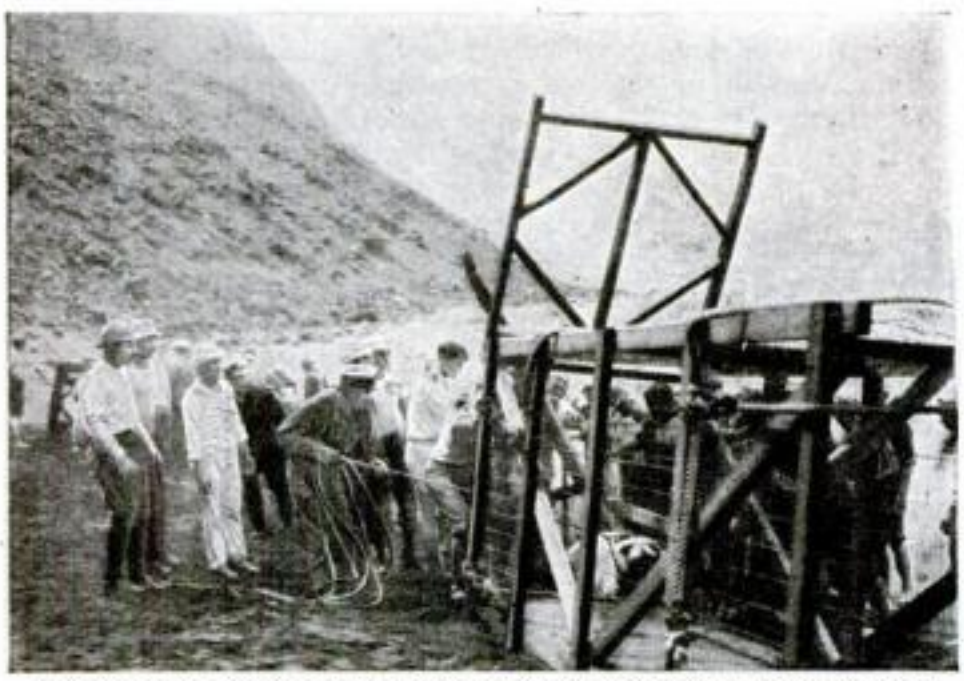
The Coast Guard tug *Koka* and an Eagle boat took the expedition to Guadalupe Island, where the herd was found basking in the sand or wandering on hillsides and ledges fifty to sixty feet above the water. The *Koka* carried five large crates, built of heavy timbers and covered with strong steel netting. These were knocked down so that they could be assembled quickly around the seals and floated ashore. It was found, however, that when a crate was assembled around an animal, it was difficult to place the bottom under the heavy beast. Thereafter, the crates were set up and the huge mammals decoyed or driven into them. Then metal tanks were attached to the sides and the crates were floated, elephant seals and all, out to the Coast Guard tug. At shipside, the tanks were removed and the crates were lifted by crane to the after deck.

Aboard ship sea water was pumped on the animals in continuous streams until the tug arrived in San Diego. There they were swung on to trucks which whisked them from the water front to a large pool in the zoo.

On Guadalupe Island the elephant seals were found to be extremely belligerent. The approach of a man was the signal for immediate opening of mouths, snarling, and snapping. The animals, however, are so heavy and slow of movement on land that they were avoided easily. When it came to getting one of them into the crates, the quickest method was to slap the animal on the trunk, when it would follow its tormentor slowly but persistently to the cage.

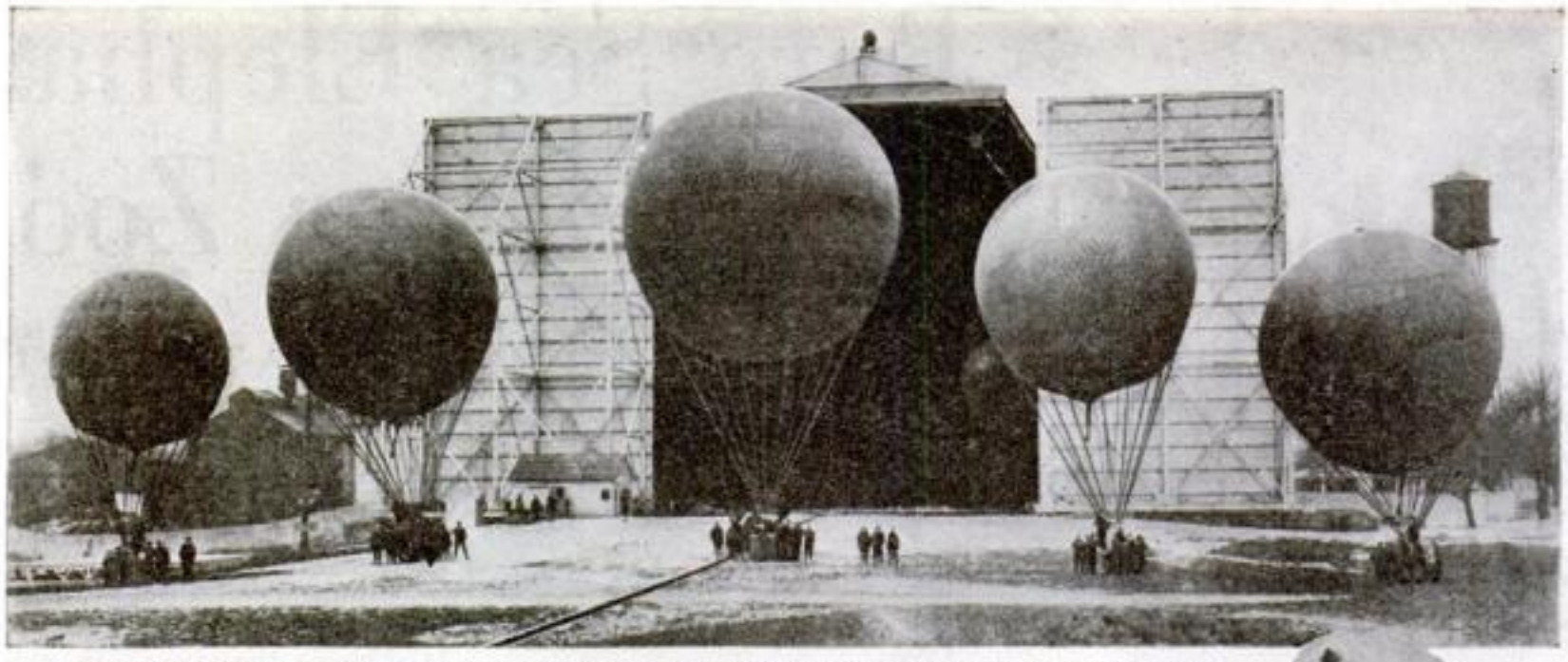
Though these animals were hunted almost to extinction for their oil by whalers of 100 years ago, it is believed that the great reduction in their numbers since about 1850 has been due to a mysterious disease. Pathologists of the University of California will study this malady to find, if possible, a remedy.

The elephant seal is a true seal, largest of the tribe, distinguished by a trunk ten to eighteen inches long, flabby and pendant when at rest but capable of inflation and use almost as a hand. Its purpose is not well known, unless it be of value in seizing swimming fish. Apparently the animals are the masters of the sea. They are unafraid of anything that swims, fighting sharks and even killer whales.



A 700-pound elephant seal calf being towed into a cage on Guadalupe Island. Since calves do not survive captivity, only adults now are caught.

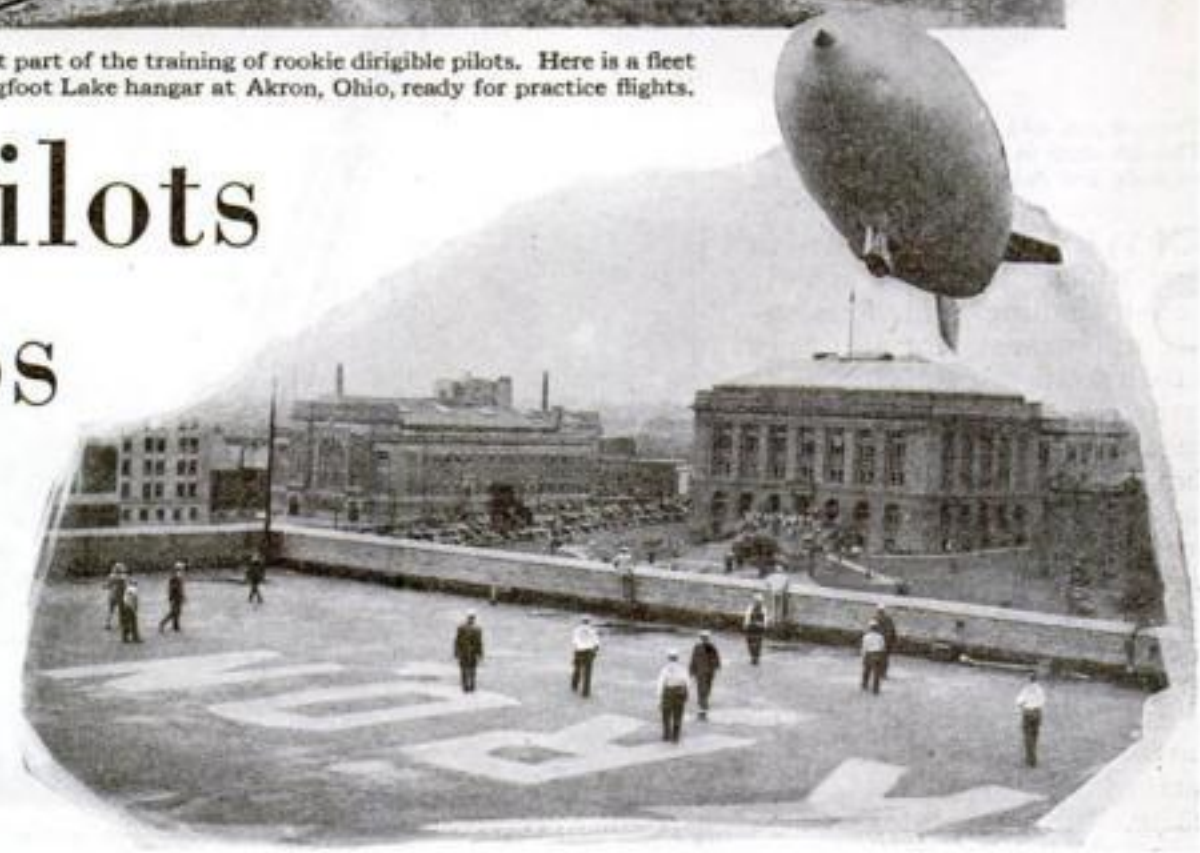
The crated "sea elephants" on the deck of the *Koka*. The animals were sprayed continually with sea water on the 300-mile trip from Guadalupe.



Ascensions in free balloons are an important part of the training of rookie dirigible pilots. Here is a fleet of the balloons lined up in front of the Wingfoot Lake hangar at Akron, Ohio, ready for practice flights.

Training Pilots for Airships

By EDWIN KETCHUM



The small dirigible *Pilgrim* demonstrating its maneuverability by landing on the roof of a department store at Akron. Students in the airship school receive their training in "pony blimps."

A FLYING school where not one heavier-than-air machine is to be found is being operated at the Wingfoot Lake Air Station, Akron, Ohio. It is a training institution for commercial dirigible pilots, and is said to be the only one of its kind in the United States.

Today six small experimental and training dirigibles are America's only commercial lighter-than-air craft. All the rest are Army or Navy machines. But recently a Massachusetts concern placed an order for a "blimp" which, when completed, probably next spring, will give New England the pioneer dirigible service of the United States. Besides two giant dirigibles under construction for the Navy, two others of equal size are projected for a future commercial air line across the Pacific to Hawaii. Special training will be needed for pilots of these and other future dirigibles. Where will they get it?

The training school at Akron is the answer. It was established last year by the largest dirigible manufacturing firm in this country, which owns the present fleet of commercial gas bags.

Applicants for the course must pass rigid physical examinations, which eliminate men with weak eyes or other disabilities. Successful entrants receive their first instruction in ground classes.

Seven ascensions in free balloons are an essential part of the student's training. An airship, no matter how large, is simply a balloon with engines and steering devices added. If anything goes wrong with the controls, the dirigible becomes a free balloon and must be flown as such. Therefore the student learns about ballooning at first hand. His seventh ascension is a "solo" balloon flight. For this he himself gives orders to the ground crew and directs the layout, rigging, and inflation of the balloon. Successfully completing the flight, he receives his balloonist's license and is ready to start training on a small "blimp."

Operation of an airship's controls is only one of the things its pilot must know. The huge gas bag on which the craft's lift depends is a temperamental affair. Sun shining on the envelope makes the ship expand and become "lighter"; a passing cloud upsets the balance. Landing an airship, too, is almost a science in itself. Aerostatics, which deals with the lifting power of hydrogen, helium, and other gases, is therefore an important part of the course. The prospective pilot is trained in aerodynamics, the science of the motion of bodies through air. In meteorology classes he learns about storms, clouds, lightning, and other whims of the weather. Besides these he masters practical and theoretical courses on engines, the design and use of instruments, navigation, free balloon design and construction, airship and balloon operation and maintenance, airship gases, aviation history, Department of Commerce rules, and radio and parachute operation.

After the ground course and the practice balloon flights, the student graduates to one of the three "pony blimps" used for training—one of 54,000 cubic feet and two of 86,000 cubic feet capacity. Numerous training flights make him adept in handling small dirigibles. Like an airplane pilot, he requires fifty hours in the air to qualify for a limited commercial airship license, and two hundred hours for a transport license.

The entire course requires six months. It could be given in a shorter time, but the longer period permits the students to be familiar with varying weather conditions.

Twenty-five students are now enrolled, all employees in the Akron dirigible plant. Before long, however, anyone may be able to apply for a course in dirigible piloting.

Ward T. van Orman, instructor and director of the Akron airship school, shown demonstrating the use of the sextant.

Useful Hints for the Radio Fan

Building a Homemade Voltmeter

Handy Voltage-Measuring Instrument Can Be Mounted in a Cigar Box—Short Cuts for Trouble Shooting

THE radio experimenter almost always is handicapped by a lack of measuring instruments. As a result he frequently spends hours looking for trouble that could be quickly spotted by the aid of an accurate electrical measuring instrument.

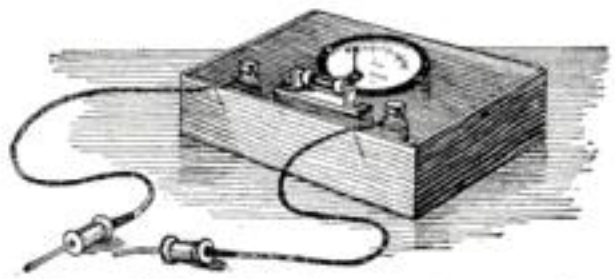
One of the most useful instruments to any radio experimenter is a direct current voltmeter with a universal range; that is, a voltmeter that will measure, with reasonable accuracy, any voltage up to the highest ordinarily used in radio receiving apparatus.

Instruments of this type are manufactured to laboratory standards and therefore are expensive. The amateur does not need such precision. An error in voltage reading of even as much as ten percent usually is of no great importance, and an accuracy within five percent is good enough for anything except laboratory work.

The illustration shows a home-built universal range voltmeter for direct current voltage measurement. It consists simply of a high-grade milliammeter with a scale reading from zero to one milliampere. It may be mounted in the top of a cigar box. Next to it should be placed an ordinary grid leak mounting and two binding posts. One binding post is connected to one terminal of the grid leak mounting, the remaining terminal of which is connected to one terminal of the milliammeter; the remaining terminal of the milliammeter is connected to the other binding post. In other words, the grid leak mounting and the milliammeter are connected in series.

The test points consist of two flexible pieces of rubber insulated wire. The strands from an electric light drop cord will do, with tips made from short lengths of ordinary bus wire or stiff copper wire. The handles can be ordinary thread spools so that the fingers need not come in contact with the bare wire ends.

The milliammeter will read voltages according to the value of the resistance placed in the grid leak mounting. For instance, with a fixed resistance of 1,000 ohms, the milliammeter will have a full scale reading of one volt. If a 10,000-ohm resistance is used, the full scale reading of the milliammeter will be ten volts. For 100 volts full scale reading use 100,000 ohms, and so on. The theory, of course, is that as the internal resistance of the milliammeter is so slight as to be negligible, the amount of current which will flow through it will be determined by the voltage applied and the amount of external resistance placed in the circuit.



A home-built universal range voltmeter, using a high-grade milliammeter and fixed resistance.

The amount of current flowing in any circuit always can be determined by dividing the voltage or pressure by the resistance in ohms. If one volt is applied and the resistance is 1,000 ohms, one milliampere of current will flow, because one divided by 1,000 equals one thousandth of an ampere, which is one milliampere, and the needle will go to the end of the scale.

The accuracy of such a meter is limited only by the accuracy of the resistances that you use. If the resistances you buy are guaranteed accurate within ten percent, which is an ordinary commercial rating, the voltages as read from the meter will also be accurate within ten percent. Still more accurate resistances are available at slightly higher prices if you wish more accurate reading. A voltmeter of this type is very suitable for use in testing the voltages developed by a B eliminator, C bias voltages developed across a resistor, and so on.

A B C's of Radio

THE potentiometer used in various ways in receiving circuits is simply a resistance with a sliding contact. The value of this resistance may range from less than five ohms to half a million ohms.

The theory of the operation of the potentiometer is simple. If you apply an electrical voltage to the end of any resistance, a voltmeter connected across the ends of the resistance will read to the amount of the voltage applied. If one of the terminals of the voltmeter is slid along the resistance, the voltage read at any point will be directly proportional to the distance between the two terminals of the voltmeter as compared with the full length of the resistance. This is true provided the resistance is of uniform value throughout its length. The principal use of a potentiometer in a radio circuit is to obtain a fine voltage adjustment over a wide range.

When the Set Goes Dead

OF THE possible radio troubles which may stop reception entirely, only a few occur with any degree of frequency. Therefore, when the set goes dead, it is well to check first the points where trouble is most likely to be found.

For example, since a burned-out tube is perhaps the most common trouble with full electric sets, look first to make sure that all tubes are working. If they glow about normal, that does not necessarily prove that they are operating with full efficiency. The manner in which the receiver stopped will give some clue on this point. If the signals gradually faded away over the course of several days, one of the tubes probably has become exhausted. The filament is lighting in the usual manner without producing the normal flow of electrons. In that case the best thing to do is to take all of the tubes to the nearest radio dealer and have them tested.

The fact that the signal faded out gradually also indicates that the trouble is not due to a broken wire, because such a break would cause the set to go out of commission suddenly.

After the tubes have been checked and it is known that they are good, the next test is to tap gently all of the tubes in the receiver with a finger nail. When the detector tube is struck there should be a clear ringing sound from the loudspeaker. If not, something is wrong in the audio amplifier end of the set, between the detector tube and the loudspeaker.

If the audio amplifier circuits are in good shape, the next step, assuming that the receiver is in a locality where there are one or more powerful local stations, is to remove the radio-frequency amplifier tube next to the detector tube, and also disconnect the antenna wire. Carefully place the antenna lead-in in the plate prong hole in the empty socket. Be sure that the antenna lead does not touch any metal in the set. With this connection the circuit becomes a plain detector circuit followed by the audio amplifier, and if signals are received under such conditions it indicates that the trouble is somewhere in the radio-frequency amplifier circuit. By replacing the tube and trying the test on the next tube in line toward the antenna end of the set, you can test the radio-frequency stages one by one and find where the trouble actually is.

In unpacking a kit set the instructions should be read carefully, and the parts checked off to make sure that nothing is missing.

New Kit Sets for the Radio Builder

Easy to Assemble, They Range from Screen Grid Receivers to Short Wave Adapters

By ALFRED P. LANE

BUILDING a radio receiver from a complete kit of parts offers fascinating possibilities to the man who likes to build things himself. And because the component parts are completely finished and all mechanical work is done, the assembling of a set from a modern kit will appeal particularly to the man who hesitates to tackle a job involving laying out, drilling, sawing, filing, and so on.

Furthermore, assembling from a kit makes possible the construction of receiving apparatus especially suited to the owner's individual requirements. For instance, one man may want tremendous volume with fine tone quality only from the local stations; another man, because of poor location or distance from broadcasting stations, may be specially interested in bringing in the distant stations, and at the same time he may desire just enough volume for satisfactory use in a small room at home. Any of these requirements can be satisfactorily met by an intelligent choice of the kit sets now available.

Beyond the tuning limit of the standard broadcast receiver, on the short wave bands, there is much radio transmission of interest to the man who is experimentally inclined. Several of the regular broadcast stations also are transmitting their programs on short waves, and it frequently happens that these short-wave programs can be heard at great distances when the regular broadcast wave is not being received at all. Then, too, there is much amateur telegraph and telephone transmission, and while short-wave transmission is subject to fading, static, and other troubles just as is transmission on the broadcast band, the persistent amateur will, in the course of time, be able to log amateur and broadcasting stations from all over the world.

RADIO kits, complete down to the last screw and nut, range all the way from fine broadcast receivers to the simplest of one-tube beginners' sets. There are also short-wave adapter units which can be assembled for use with any standard broadcast receiver.

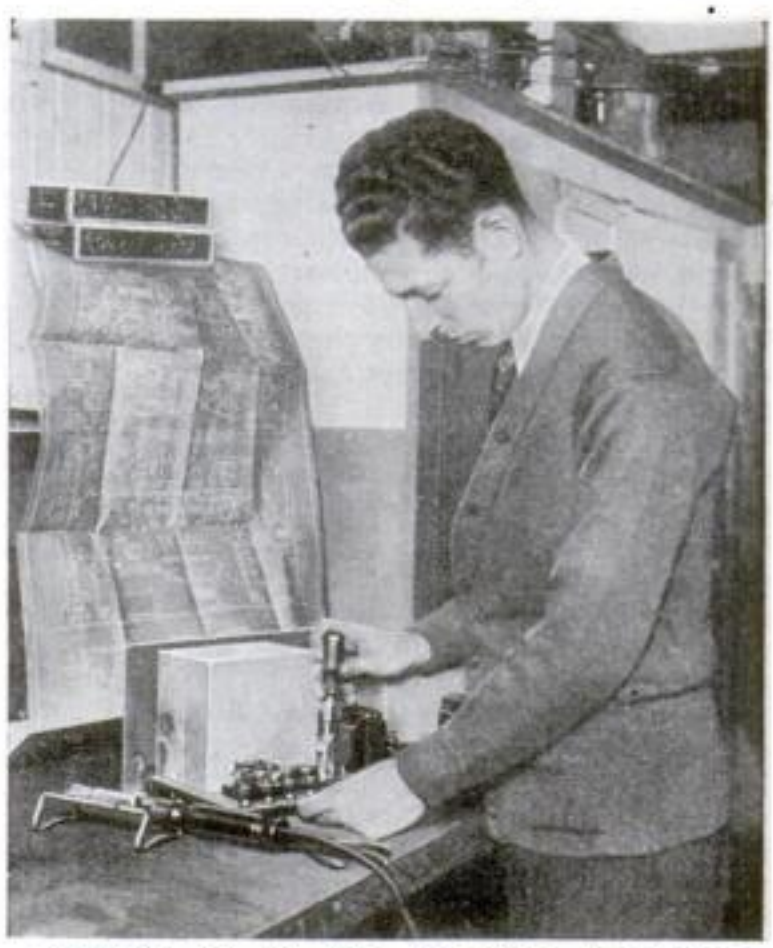
The most elaborate radio kit set being offered this year will, when correctly assembled and wired, compare favorably in performance with the finest of factory built receivers. It is, of course, a screen grid receiver using three screen grid tubes of the new A. C. type. Each of the three stages is tuned; and the signal, before reaching the first radio amplifier stage, is fed through a pre-selector circuit. Thus, before it reaches the detector tube, the signal passes through six tuned stages. The result is extraordinary selectivity; but because the individual stages of radio-frequency amplification tune relatively broadly, and because the pre-selector circuit has band-pass characteristics, there is no appreciable cutting of the side bands and the tone quality, therefore, is excellent. A single drum dial controls all six stages. After passing through a conventional detector stage using the type 227 tube, the signal is fed through a stage of transformer-coupled amplification using the type 227 tube and then through a push-pull amplifier stage using power tubes type 245. A jack is provided so that an electric phonograph pickup can be used, and as this connection is made to the grid of the detector tube, the amplification of phonograph records is of a very high order.

This particular kit includes a complete power supply circuit with a type 280 full wave rectifier tube used to supply the high voltage direct current that is required by the B circuits. The primary of the power transformer is connected to the 110-volt line through a voltage regulator tube. Line voltage fluctuations are automatically balanced out and the voltages supplied to the set are uniform regardless of changes in the voltage of the electric light line.

The individual parts of this circuit are available separately so that radio fans who wish to use the same system of preselection and radio-frequency amplification with some other type of audio amplifier or power circuit may do so with the minimum amount of trouble.

A kit with interesting possibilities for the man who wishes to find what is being transmitted on the short waves consists of a stage of tuned radio-frequency amplification using the screen grid tube with a regenerative detector—a necessity in any receiver designed to receive amateur short-wave transmission—a stage of resistance coupled audio amplification, and one stage of amplification using a transformer. This particular receiver uses plug-in coils so that it tunes all waves from fourteen meters up through the broadcast band. No power supply unit is included in this kit, so that the purchaser may either build one according to his own ideas or purchase any one of a number of separate kits made for the purpose.

SHORT-WAVE adapter kits are, of course, useful both to the owner of a receiver built from a kit and to the owner of any standard factory built receiver. The short-wave kit takes care of the radio signals that pass the detector stage and consequently it is fitted to the broadcast receiver by means of a plug which takes the place of the detector tube in the broadcast set. The audio amplifier circuit in the broadcast set is used to amplify the signal produced in the short-wave adapter unit. This type of kit can be used with any receiver having an audio amplifier. The type of radio-frequency or detector circuit used in the broadcast set is of no importance, since it is not



Assembling the set from instructions. Screwdriver, pliers, and soldering iron are about all the tools needed.

used in connection with the short-wave adapter unit.

Another kit now available is of particular interest to persons living in sections of large cities where only direct current is available. The D. C. type radio kit has a peculiar arrangement of tubes, there being four 112A and two 171A tubes. They are connected in a series-parallel arrangement.

THE 171A tubes are, of course, in a push-pull audio stage, and while the power output because of the limited voltage available is not equal to that of a receiver operating on alternating current using the same two power tubes, very satisfactory loudspeaker results are obtainable; and, of course, the tone quality within the volume range of this particular circuit is just as good as with receivers designed for use on alternating current.

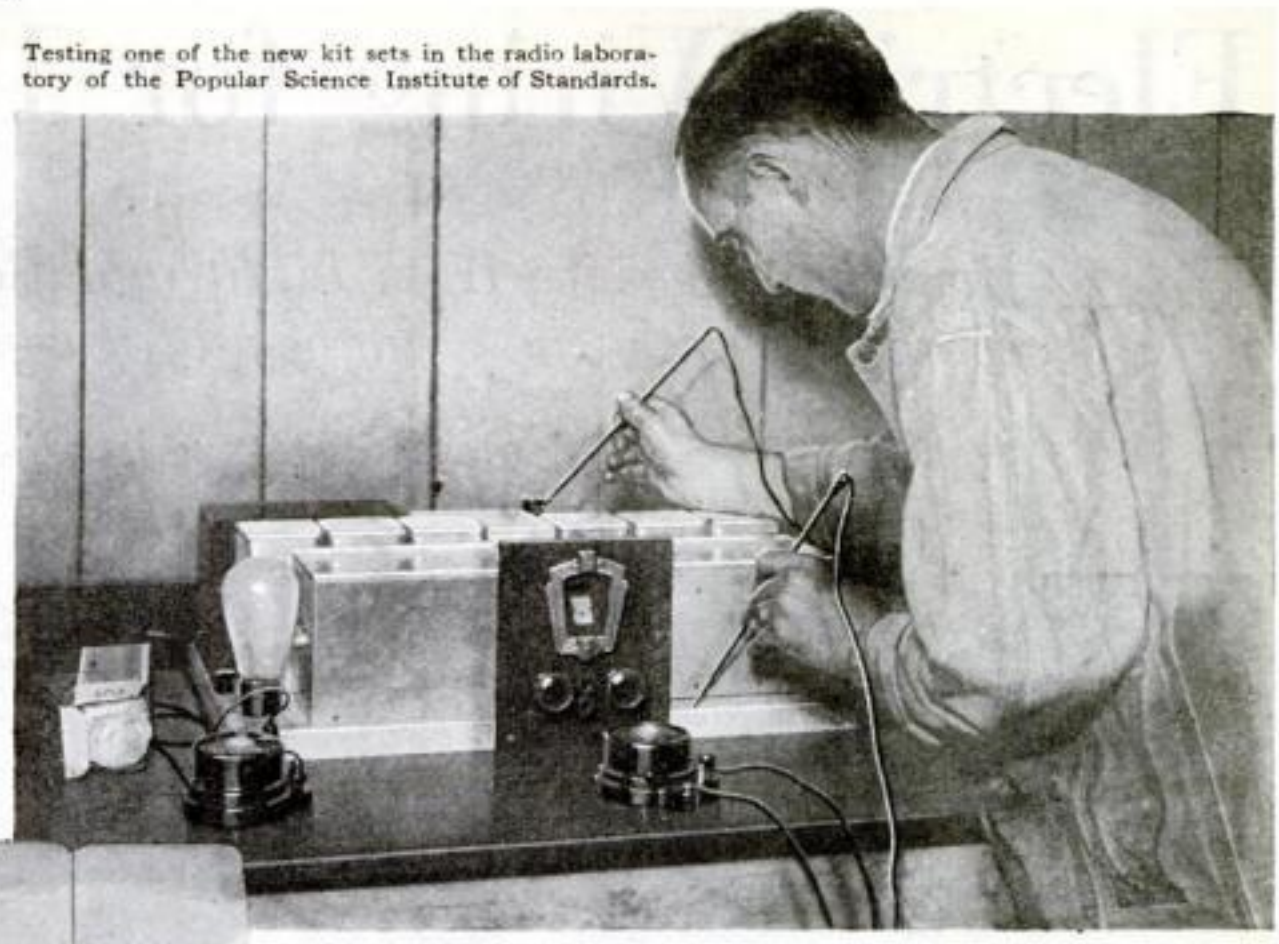
Battery type tubes are used in such a receiver because the filament current in amperes is relatively lower than with A. C. type tubes. Consequently when the tubes are connected in series the current drawn from the 110-volt line is held to half an ampere—the amount of current drawn by an ordinary fifty-watt light.

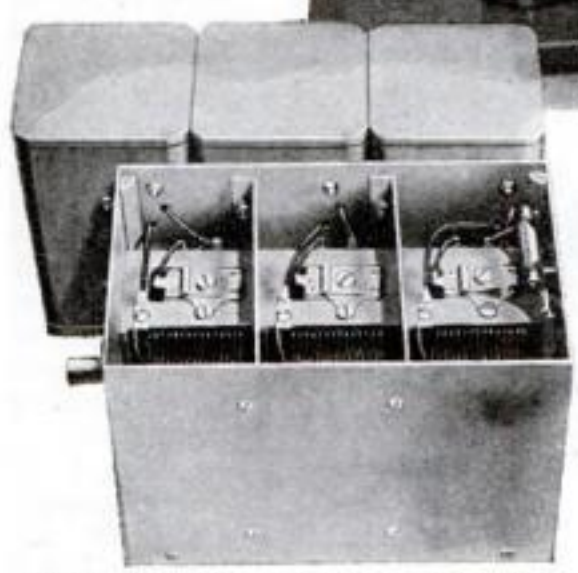
Many of the new kits, of course, include the entire radio receiving circuit, but it is also possible to obtain several of them minus the audio amplifier circuit. Thus the radio-frequency and detector tuning units may be used with any one of the many power amplifier kits now available.

Although no cutting, drilling, or other wood or metal working operations are necessary to assemble a kit set, certain tools will be needed. Of course, a screw driver is necessary, for most of the individual parts are bolted or screwed to the base or to each other. In some of the kit sets the wiring has been greatly simplified, but in all of them wiring is necessary. A soldering iron, preferably of the electric type, should be available; also some rosin-core solder. The necessary wire is supplied with some kits. If not, a supply of rubber-covered hookup wire will be needed. This wire is stranded so that it is very flexible and has a thin coating of rubber. Of course, a pair of wire-cutting pliers will be necessary, and it is also desirable to have a pair of long-nosed pliers, which will be handy to hold the wires while they are being soldered in place. The pliers will also serve to hold the nuts while the screws are being turned by the screw driver.

THE individual component parts of the various kit sets approved by the Popular Science Institute of Standards are high grade in every respect and will perform in the radio circuit exactly the service required of them. Furthermore, the parts are easily fitted together. It must be remembered, however, that the work of assembling and wiring a radio set is just like any other assembly job. The final result will be satisfactory only if the work is carefully done exactly in accordance with instructions.

Testing one of the new kit sets in the radio laboratory of the Popular Science Institute of Standards.





Three stages of tuned radio-frequency amplification in a kit using screen grid tubes.

Completedetailed instructions always accompany a radio kit set and the first job, therefore, should be to study these instructions with the greatest care. Even before any of the individual parts are unpacked the instructions should be gone over at least twice. Then the parts should be unpacked one by one and checked against the material list to make sure that none is missing. Extreme care should be taken that the original boxes or wrappings are not thrown away until it is certain that no small parts, such as screws and nuts or other fittings, still remain concealed in the wrappings.

Most kits are assembled with standard sizes of screws and nuts so that if any are lost they can be replaced at the nearest hardware store, but it is exceedingly annoying to stop the assembly work simply because one or two screws or nuts have become lost in the unpacking process.

It is a good idea to test the individual small parts before starting assembling. Resistances of the fixed and variable type should be tested to make sure that they are not defective. All such resistances are, of course, tested at the factory; but there always is a bare possibility that one will be defective, so that no current can flow through it. It is much easier to locate a defective fixed resistance before it is placed in the set than afterward. The simplest method of testing is to connect the resistance in series with a small C battery and a pair of headphones. When the circuit is closed a distinct click should be heard, and another click when the circuit is opened.

THE wiring job on most of the modern kit sets has been made extremely simple. In fact, it is easier to wire some of the more elaborate modern kits than it used to be to wire a small three- or four-tube set in the days of battery operated receivers. However, mistakes are still possible. A single error at any point in the wiring is practically certain either to make the receiver inoperative or greatly reduce the efficiency with which it will bring in stations and put them on the loudspeaker.

If the kit set is of the type that is assembled on a metal base, be careful to guard against short circuits caused by drops of solder projecting from the soldered connections to the metal base. Also make sure that no detached gobs of solder roll into places where they can cause short circuits.

There really is no excuse for making any mistake in wiring a kit set. Large and clear diagrams are supplied with all kits, and if the builder carefully follows the diagram and checks off on it each wire as he puts it in place there will be little chance for error. One of the best methods is to use a red or blue pencil and go over the lines in the diagram representing the wire that has been soldered in place just as soon as the connections have been made.

THOUGH radio has "grown up," important new refinements are being introduced constantly. Each month POPULAR SCIENCE MONTHLY keeps you abreast of the latest developments with informative articles and helpful suggestions. Questions concerning your radio problems will be gladly answered. Address the Radio Editor, in care of this magazine.

Electric Wiring for 1930 Homes

Household Service from Light and Power Appliances Increases with the Number of Circuits and Outlets

By ROGER B. WHITMAN

WHEN Edison invented the electric lamp fifty years ago, and asked people to run wires into their houses for light, it is hardly possible that even in his wildest dreams he guessed that within a half-century those same wires would be serving at least sixty-six other household purposes, ranging from opening doors to curing disease, and from cleaning rugs to warming the baby's bottle. So swift has been the advance that now it is easier to list the household needs that cannot be met by electricity than to reckon those that it makes possible.

As the electric light has made a memory of the cleaning and filling of oil lamps, so has electric power thrown the old-fashioned spring housecleaning into the discard, and in scores of ways has given the housewife more hands to do things with. To make use of this power is to save time and energy and to gain leisure and strength for doing pleasanter things than housework. But are people in general taking advantage of it?

To this question the answer must be no, for electric power cannot be used to its fullest extent in a house that is not completely wired—and a recent and accurate count has proved that in the majority of American dwellings the wiring is inadequate. The examination covered many thousands of houses of all ages and values and in every part of the country. It showed that only a few came up to requirements for the full and convenient use of lights and of labor-saving appliances. All of the houses found to be adequately wired were less than five years old, and were built by the people who were to occupy them. Here is proof of the increasing application of electricity in daily life, for when the other houses were built the wiring of many of them was considered to be up-to-the-minute in completeness. Only five years ago there were no exercising machines, violet ray lamps, or electric radio sets. Apparatus in common use today was not even on the market. With uses for electricity developing so rapidly, there is every probability that in another five years those well-wired houses will also be obsolete.

THE difference between a house that is well wired and one that is not is in the wiring and the number of outlets. In the past, houses were wired only for lights, and when appliances were used they were plugged into the lamp sockets. The circuits not being able to carry the extra load, the fuses blew, and the next step was to put in heavier wiring and outlets for appliances. The growing number of

Electricity has made a memory of old-fashioned oil lamps and the drudgery of annualhousecleaning.

appliances caused this change, and the time has now come when, for comfort, convenience, and the saving of labor, even the smallest rooms should have at least two outlets, adequately wired to prevent overloading.

The lighting needs of a house should be considered separately from the other uses of electricity, and should have their own circuits. The number and placing of the lighting fixtures should be determined by the floor plans and the setting of the furniture. Control should be by wall switches beside the doors, and use should be made of what are known as "three-way" switches. With these, a lamp or group of lamps can be turned on or off from either of two locations. They are ordinarily used for hall lights, with one switch upstairs and the other down; but it is a convenience to have one at each door of a room, so that a light may be switched on when entering by one door and turned off when leaving by another. With such switches a porch light may be turned on outdoors and put out after entering the house, and in a bedroom the lamp can be lighted at the door and extinguished, after retiring, by a second switch at the head of the bed.

NEXT month Mr. Whitman will describe the latest improvements in plumbing systems and fixtures. If you are planning to build a new house, or to modernize the old one with additional conveniences, you will find his suggestions helpful.

APPLIANCES will work from lamp sockets, of course, but the far more satisfactory way is to make connection at convenience outlets. A special outlet for the vacuum cleaner and floor polisher should be provided in every room. The best location is waisthigh beside the door, so that connection can be made without stooping. The outlet may be in the same plate as the lighting switch, and will be found useful also for a spray for paint and for insecticides.

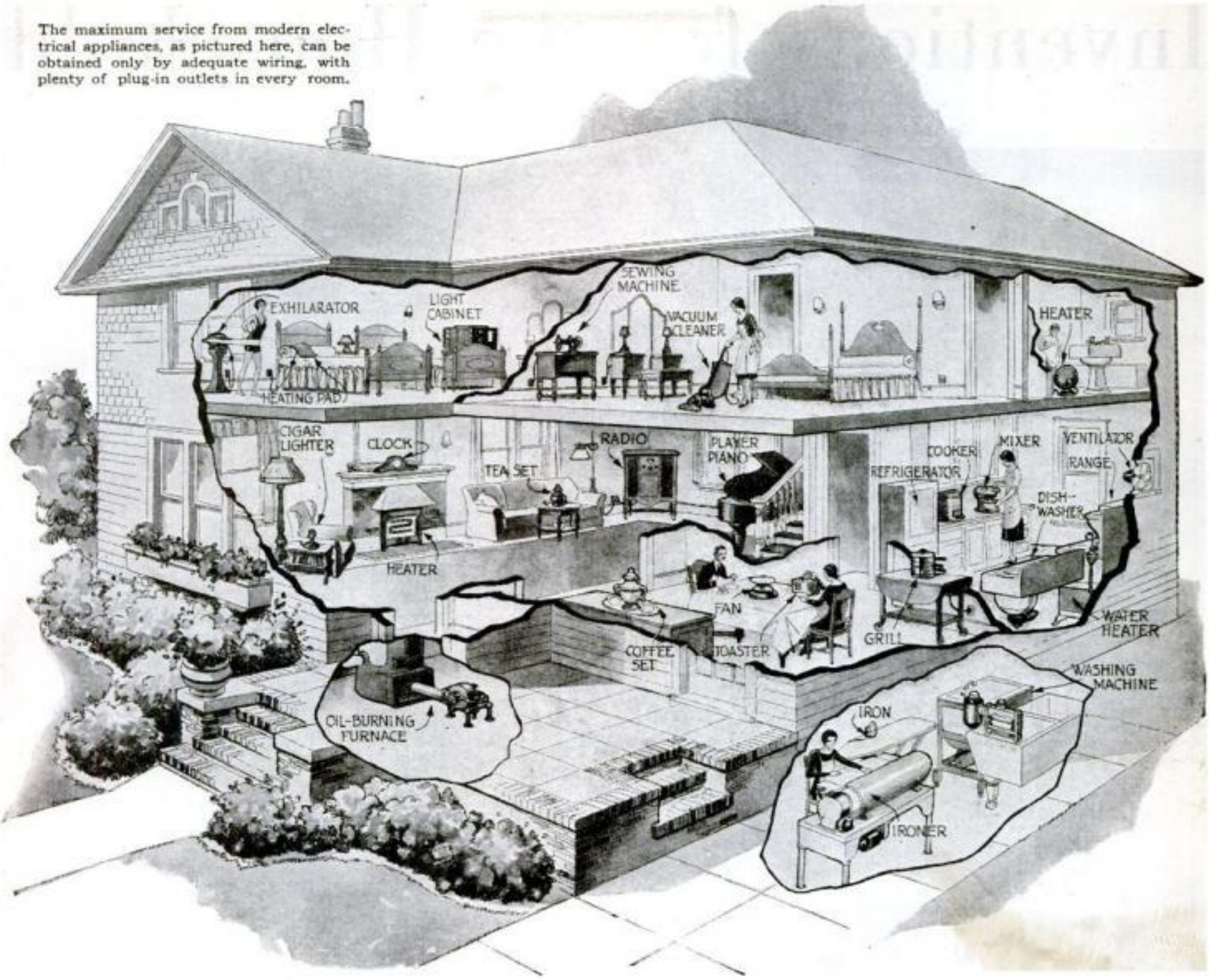
Other appliances are not usually moved from room to room, and so a plan for wiring should begin with a listing of all parts of a house and of the appliances that will probably be used in each. In the laundry, for instance, there should be outlets for the washer, dryer, ironer, and hand iron. There may be constant service in the living room for an electric piano, motor-driven phonograph, electric clock, radio, and possibly for a humidifier or an ozonator to remove smoke and odor. Since it may not be desirable to break any of these connections for occasional apparatus such as a movie projector or Christmas tree lights, additional outlets should be provided for these temporary needs.

THE breakfast nook should have at least three outlets for cooking utensils, on a circuit that will carry the heavy load. When one end of the table is against the wall, these are most conveniently placed on the wall just above the table top, so that the cords may be short. The kitchen will require the greatest number of outlets. The refrigerator, dish washer, and ventilating fan each should have its own, while other outlets should be provided on the wall above the work table for stirrers, beaters, choppers, polishers, and other power-driven kitchen utensils.

A bedroom should have two groups of outlets—one at the head of the bed for a heating pad, immersion water heater, sun lamp, and therapeutic apparatus; and the other at the dressing table for curling tongs, vibrator, violet ray bulb, and similar toilet devices. Elsewhere in the bedroom there may be outlets for a sewing machine, light-bath cabinet, health motor, and electric massage machine.

Apparently there is no end to the development of new appliances or to improvements on the old. Toasters are now self-timing, for instance, so that when a slice of bread has reached the right degree

The maximum service from modern electrical appliances, as pictured here, can be obtained only by adequate wiring, with plenty of plug-in outlets in every room.



of toastiness it is ejected. Egg boilers, too, stop automatically when the eggs are done. Waffle irons have indicators that show when they are heated sufficiently to prevent the batter from sticking, and smoothing irons have thermostats to keep them from overheating.

VACUUM cleaners now are made in small sizes for hand use, being in the same relation to the large models as a brush to a broom. Clothes washers, too, are made in miniature for the washing of a few handkerchiefs or baby clothes; being light, they can be used in a bathroom and stored in a closet. Even garage doors now are opened by electricity, to the great convenience of the motorist. In one type of door opener a switch on a cylinder lock set in a post beside the driveway controls a motor that opens the doors, and also turns on the garage lights and an outside flood light. Throwing a second switch inside the house closes the doors and puts out the lights.

Householders nowadays can exercise with electric motors, clip hedges and mow lawns by electricity, take sunbaths on rainy days and spray paint instead of brushing it. They can cook, stir, polish, curl hair, massage, take violet ray treatments, wax floors, and do a variety of other things with the same power—provided always that the necessary connections are available and that the circuits can carry the load. Any home builder, with this power at his disposal, is handicapping himself if he fails to wire his house to make the fullest use of it.

In addition to the circuits supplying the regular needs of a house, others may be provided for special purposes. For example, there may be one connected to a light in each part of the lower floor and controlled by a switch upstairs; in the event of a burglar scare the throwing of the switch will flood the downstairs rooms with light. The illumination of a garden, or the lighting of a living tree during the holidays, calls for weatherproof circuits outside the house.

Although the wires used for house circuits are always coated with tough insulating material, wiring must have greater protection than this against the gnawing of rats and mice, possible damage from accident, and moisture. In a widely used and efficient method, the wires are wrapped at the factory with layers of steel ribbon that protect against damage of all kinds.

There are many applications of electricity in a house beside those using current from a central station. One is a system of call bells; another is a fire alarm device that automatically rings a bell when abnormally heated; a third is the thermostatic control of the dampers of a heater to maintain even temperatures. A house also can be wired for the antenna and ground connections of a rádio set and for the operation of loudspeakers in any room.

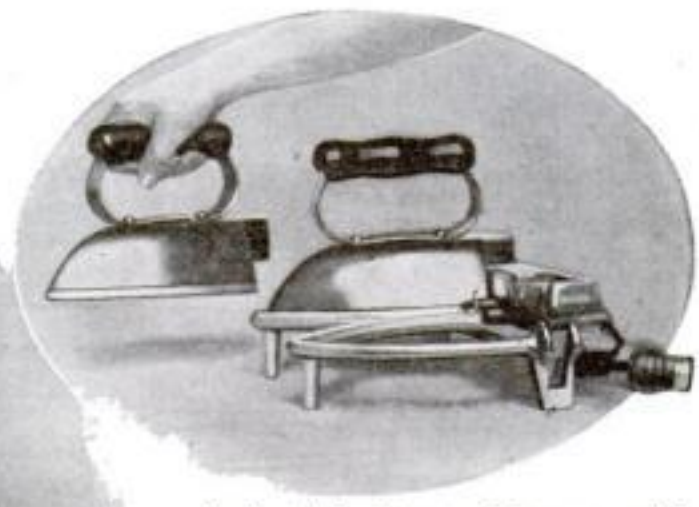
Telephones were formerly installed after a house was finished, with the wires exposed and liable to injury. Now the telephone wires are laid while the house is being built, with branch lines extending from a fixed instrument to outlets in all of the principal rooms for the plugging in of portable sets. The wires are carried in steel pipe conduits installed by the owner, the telephone company drawing them through and making connections at a small charge for each outlet. Charges are based on a monthly rental for each instrument, of which the owner can have as many as he desires. In addition to the thorough protection of the wiring, the convenience of this lies in having telephone service available anywhere in the house with a minimum number of instruments.

SINCE uses for electricity and new appliances are being developed almost daily, it is shortsighted to limit the wiring of a house to present uses. The installing of additional circuits is cheapest while a house is being built, and there is every assurance that the future will find all of them fully employed.

Inventions for the Household

Toasted rolls for "hot dog" sandwiches are among the possibilities of this novel electric device. When a long roll is pushed on one of the pronglike heating elements, its inside is toasted and a hole is left to receive either a frankfurter or other sandwich filler, such as chopped or sliced meat, salad, egg, or cheese.

This tightly sealed pressure pot cooks foods rapidly and preserves their natural flavor. A signal whistle blows when food is done.



An electric heating stand does away with bothersome cords for irons. Placing the iron on the stand switches on the heater.

Dry cleaning at home is said to be safe and convenient in this liquid-tight box turned with a crank. A non-explosive fluid is used as a solvent instead of gasoline.

Milk bottles, including the baby's bottles, are readily washed by this attachment to the kitchen faucets. The upturned nozzle sprays the bottles thoroughly with warm water. The device can be attached in a moment.

A dining cabinet of many uses. It includes china and linen closets, folding dining table and benches, a concealed ironing board, and a shoe-shining outfit. Above: Ironing board unfolded.

At right: The shoe-shining compartment of the cabinet shown above. It includes a foot rest which slides out and a small shelf to accommodate polish and brushes.

An adjustable speed control on this new electric mixer gives it a wide range of usefulness, from whipping cream to mixing heavy cake batters. Said to do the work in one tenth the time required by hand, it is well balanced enough to stand alone, leaving the hands free.

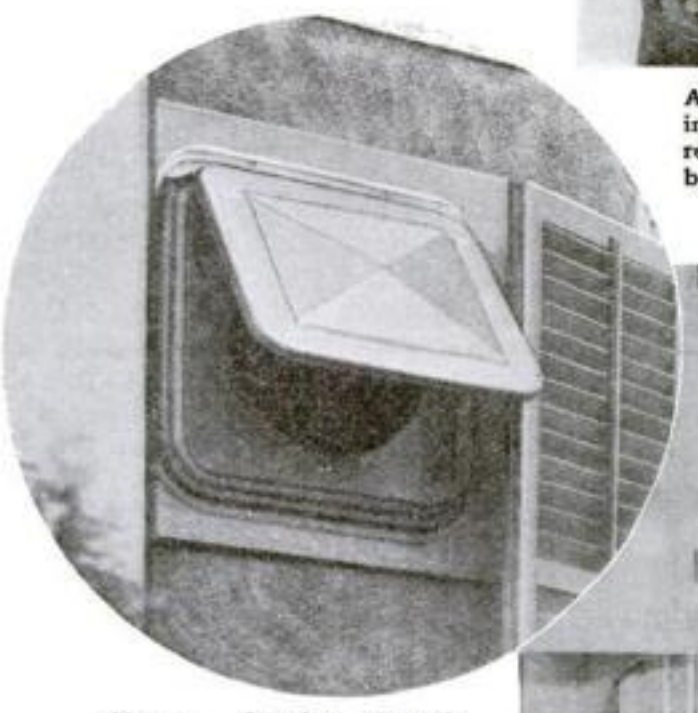
Ingenious Devices Designed to Lighten the Work of Housewives and Provide Comfort in the Home

This clothes washer operates like a percolator. Hot soapy water rising through the central spout is sprayed over clothes and seeps through them.

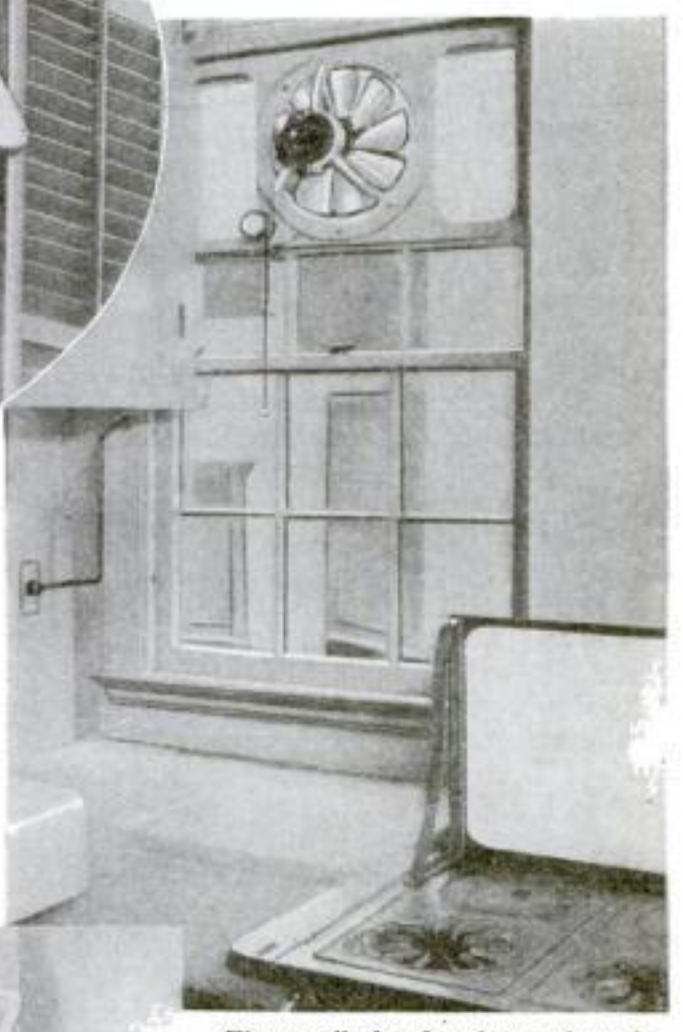
"Percolator" washer is filled with water, soap, and clothing and put on a stove.

A touch of a button opens a trapdoor in this new ash tray and drops cigarette stubs and ashes into a container below, which can be emptied readily.

An ironing board that folds automatically in one movement has a metal holder for the hot iron. One end of the board can be raised so that skirts to be ironed can be drawn over it.



Above: Opening through which a new electric ventilating fan, built into the wall, sucks out kitchen odors, substituting fresh air. The opening inside the house is shown in the photograph below.



The ventilating fan shown above is mounted in a panel designed to fit above an opened window. It has glass panes on each side of the fan to conserve light when there is a scarcity of windows in the room.

Pressing a spring tilts the top of this breakfast-in-bed table to any one of three angles, forming a book support for those who like to read in bed. A rack at the bottom keeps the book from sliding off. The table should prove especially useful in the sickroom.

Fresh air comes from outside through opening shown in circle above and is forced into the kitchen by a fan built into the wall (left). In the winter flaps keep out the frigid air when the fan is not working.

Steering the Car out of Trouble

A Woman Driver Learns from Gus a Few Simple Rules for Turning and Backing without Hitting the Curb—or Worse

By MARTIN BUNN

"I don't see how I could drive in any straighter," said Mrs. Sedgwick. Joe grinned.

"WATCH out," Joe Clark called warningly to his partner, Gus Wilson. "Here comes Mrs. Sedgwick trundling her combination rolling nursery and dog kennel."

Gus looked up from his work just in time to see Mrs. Sedgwick cut in to the Model Garage gasoline pump so closely that the rear wheel bounced over the curbing.

"There," she said pointedly, "I hit that curb again. Too bad, Mr. Wilson, that you didn't make your driveway wide enough so that a car can get into it without bumping into something."

Joe repressed a snicker as he started the gasoline flowing, for the driveway was plenty wide and the curved approach was not especially severe.

"I guess it ought to be a little wider," agreed Gus placatingly, "but if you'd cut over a little further when you drive in I am sure you wouldn't have any trouble."

Whatever reply Mrs. Sedgwick may have made was drowned by the clamor of the children, accompanied by the yapping of the dog.

"Dear me," complained Mrs. Sedgwick distractedly, "every time I stop, the children insist on getting ice cream cones. As I was saying," she went on, "I don't see how I could drive into this place any straighter. I know the front wheels were exactly in the middle of the road."

"That's just what's the matter," observed Gus with a smile. "Joe," he said, "why don't you take the kids down and get them some ice cream cones. Meanwhile, I'll show Mrs. Sedgwick some tricks in handling a car."

MRS. SEDGWICK nodded agreement and Joe started down the road with a youngster dangling on each arm and the dog hopping about underfoot.

"Well," observed Gus, "one thing that lots of drivers never seem to get the hang of is maneuvering a car in close quarters. That's your trouble, Mrs. Sedgwick. There's nothing hard about it—if you'll once get straightened out on just what goes on when you turn the steering wheel. The car really doesn't turn. It's dragged around when you're going forward, or pushed around when you're going backward. When you turn the steering wheel the front wheels, instead of rolling straight ahead, start rolling off at an angle and they pull the front of the car along with them. The rear wheels actually resist this motion. They are being pulled out of the line that they naturally would roll in.

"The next thing to get settled is the fact that the front wheels and the rear wheels never roll in exactly the same track except when the front wheels are pointed straight ahead. The minute you turn the front wheels in either direction the car makes four tracks on the ground, two for the front wheels and two for the rear wheels. The third point is that whenever you go around a curve the tracks of the rear wheels always are nearer the curb than the tracks of the front wheels. That's why the back of the car may hit something even after the front clears it."

"It's funny," exclaimed Mrs. Sedgwick, "that nobody ever bothered to tell me that before. Now I can see why I keep hitting curbstones with the rear wheels when I go round corners real sharp. Just for fun, I think I'll drive out and then drive in again and see if I can do it without hitting the curbstone this time."

"That's the idea," said Gus; "and when you come in this time steer the front wheels over a ways toward the outside edge of the drive. Then there'll be room for the rear wheels to cut inside them and still clear the curbstone."

NEXT month—the facts about present-day gasoline. An expert tells what science has found out about engine knock and other fuel problems of vital interest to every automobile owner.

Gus watched while Mrs. Sedgwick drove around again. This time she cleared the curb by at least a foot.

"You've got the idea now," said Gus. "The next thing is to back up right. In backing, you figure things out exactly the reverse of driving forward. The front wheels, now at the rear, always go outside the curve of the rear wheels. Backing into a curved driveway isn't hard if you remember to steer so that the rear wheels hug the inside edge of the driveway. Then there will be plenty of room for the front wheels to swing outside them without hitting the other side of the driveway. Suppose you go out on the road now and try and back in in front of the gasoline pump. Take it slow."

Mrs. Sedgwick tried it with only fair success. She cut in so close that the rear wheel jammed against the curb.

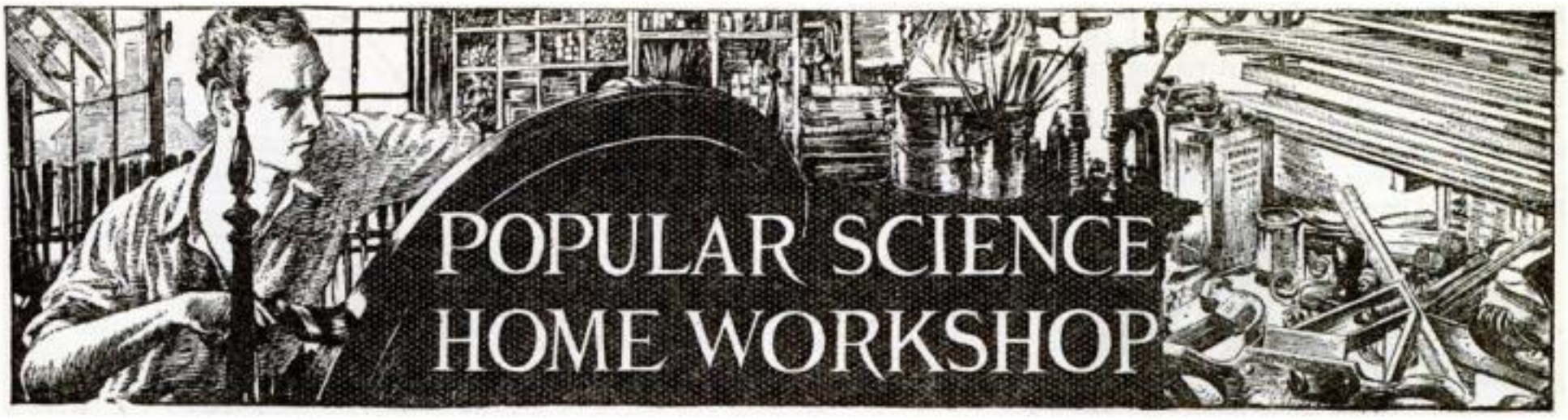
"IT'S so confusing," she said, "to try to remember which way to turn the wheel when you are steering backward. I always turn it the wrong way."

"That's natural," explained Gus. "The trouble is when you are going backward the steering wheel seems to work the wrong way. Try to forget there's a steering wheel, and while you are looking out the window backwards place your forearm across the wheel with your right hand grasping the left edge of it. Then remember to pull your hand toward you when you want the car to turn toward the side on which you are looking, or push your hand away from you if you want the car to turn the opposite way."

Mrs. Sedgwick tried it again, and managed much better.

"I certainly am grateful to you, Mr. Wilson," she smiled enthusiastically. "Is there anything else I ought to know?"

"Just one thing," said Gus, "and that is, take your time. If you get confused, throw the gear lever into neutral, put on the brake and figure out what to do."



Solo Flying for Young Aviators

How to Construct a Small Cockpit with Controls That Operate a Miniature Plane

By CHARLES A. KING

Much can be learned about the operation of a plane from this miniature cockpit and controls.

EVERY boy has at some time imagined himself seated at the controls of a speeding pursuit plane, conscious only of the drone of the motor, the whir of the "prop," and the hum of the strut wires. He banks the plane, goes into a gradual groundward glide, and levels the plane off just enough to bring the ship down in a three-point landing.

Dreams such as these come nearer to reality when he seats himself in the miniature cockpit illustrated, "feels" the controls, and sees the model plane go through all of the flying "paces" under his own guidance.

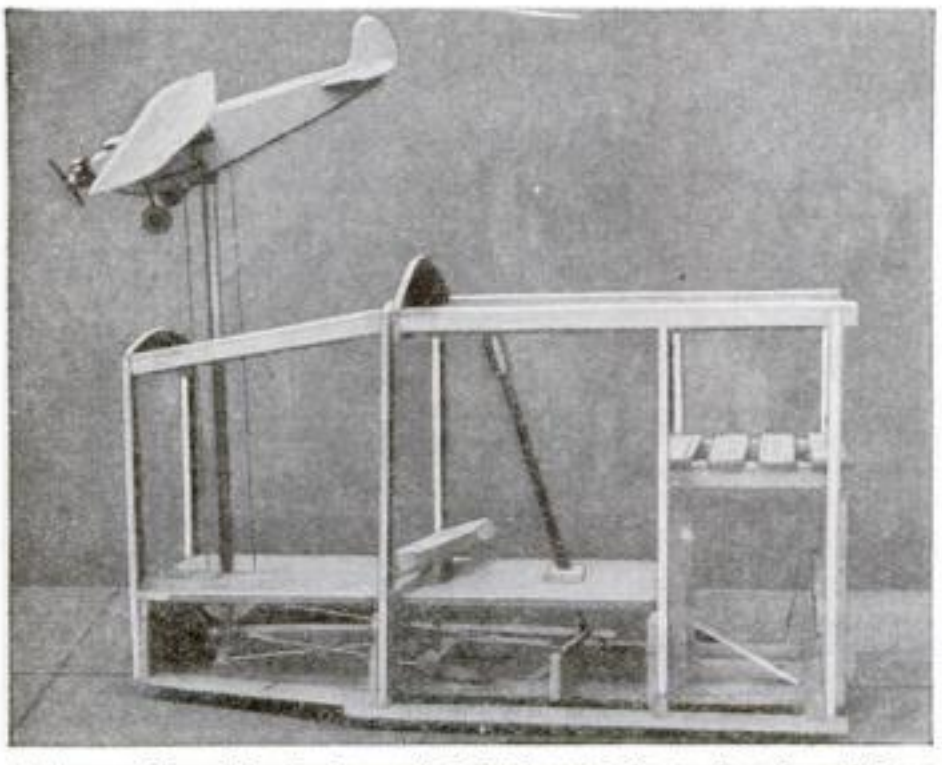
For those who wish detailed scale drawings, a blueprint has been prepared which shows the complete construction and also the details of each complicated part. This can be obtained by sending twenty-five cents for POPULAR SCIENCE MONTHLY Blueprint No. 114 (see page 99).

The materials needed in the construction are lumber, hinges, picture wire, pulleys, turnbuckles, nails, screws, screw eyes, small bolts, a few old broomsticks or rake handles, a piece of old automobile inner tube, and some 3/16-in. wall board.

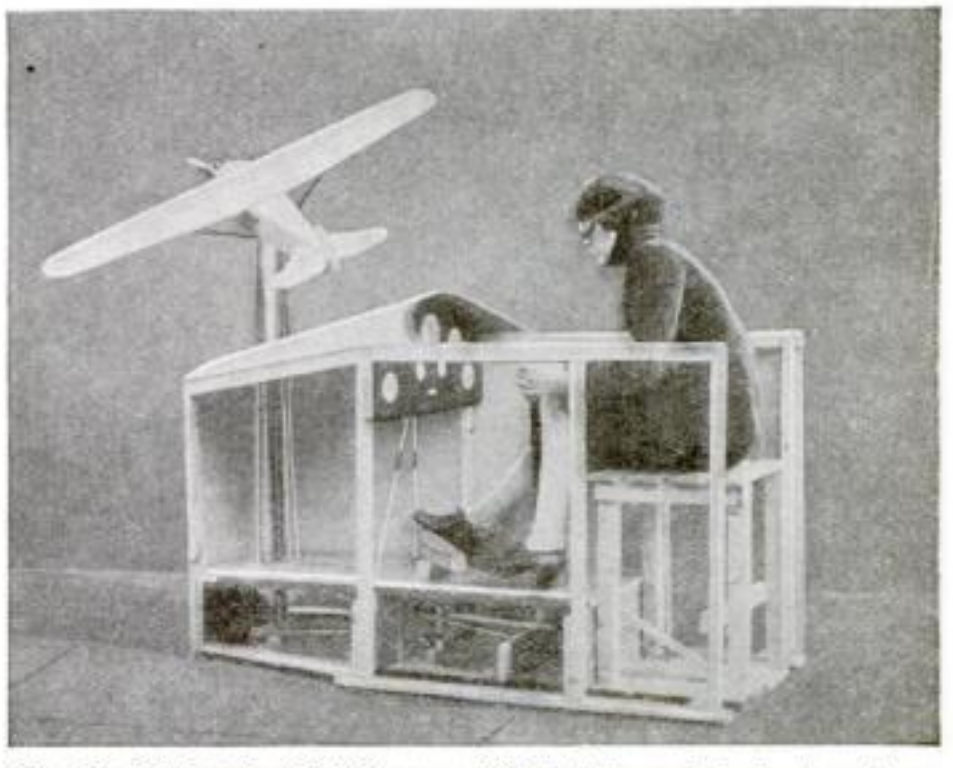
If desired, old canvas can be used for the sides of the fuselage and thus make unnecessary the purchasing of wall board. The lumber can be salvaged from packing cases.

The first step is to make the bottom (Fig. 4), which is 3/4 by 15 in. by 5 ft. 2 1/2 in. This rests on 3/4 by 2 in. cleats and is nailed to them. Two of the cleats are 26 in. long and one is 18 in. long. The three floor supports—two 3/4 by 8 in. by 2 ft. and one 3/4 by 8 by 15 3/4 in.—are next cut and put in place. Fasten the two pulleys *C* and the screw eyes to the 2 1/2 in. wide support *D*, which is braced by *E* (Figs. 2 and 4).

Lay out the floor and bore holes for the plane post, rudderpost, and joy stick. Indicate the direction of the banking wires *K* on the underside of the floor, remove the floor, turn it bottom up, and fasten the pulleys C^1 to coincide witb wires *K*.



A large portion of the lumber needed for the cockpit can be salvaged from big packing cases. If so desired, old canvas can be used in place of the 3/16-in. wall board as a covering for the sides of the fuselage frame.



One side of the cockpit is left open until all of the control wires have been put in place and all the final adjustments have been made. Blueprint No. 114 shows the complete construction and details of each complicated part.

Replace the floor and fasten it in place.

Make the rudder control yokes *L* and *M* to fit the plane post and rudderpost. Attach the screw eyes as shown in Fig. 4. The plane post and rudderpost can be made from old broom or rake handles.

The rudder bar *A* and its supporting block should be made next and assembled

Fig. 1. (*1* to *8*) Speed indicator, bank indicator, clock, tachometer, water gage, oil gage, altimeter, and magnetic directional compass.

with the rudderpost, yoke *M*, and pivot block *G*.

After making the top of the model post out of pine or any available wood, assemble it with its corresponding yoke *L* and pivot block *F*.

The altitude mechanism *R*, consisting of two pieces as shown in Fig. 2, is assembled next, using ½-in. loose pin butts (hinges). Fasten the pivot piece to the underside of the floor with 1½-in. No. 10 screws driven in from above.

Fasten the free end of the bottom hinge to the connecting rod *O*, which is made to the shape shown in the plan of the bottom, Fig. 4. Make the joy stick *B* out of a broom handle, place a bicycle handlebar grip on the outer end, and fasten the stick in the pivot socket with a tenpenny nail used as a pin. Attach the connecting rod *O* to joy stick *B* with a ¼ by 2 in. bolt.

Build the seat as shown, using several braces to insure the rigidity of the whole.

The universal joint *P*, on which the model plane rests, should be made of hardwood. It is constructed as shown in Fig. 2, using 1¾-in. butts throughout. Back out all of the pins in order to facilitate assembling. Attach this joint to the top of the model post.

Wire the rudder control mechanism next, using ordinary picture wire and attaching the two wires to the two screw eyes on each yoke (*L* and *M*).

In order that the controls will be self-returning, rubber springs *H* are used. These are made by cutting sections from an old inner tube and holding them at the ends by means of clips which hook over the screw hooks. If different sizes of inner tube are used in the construction, care should be taken to be sure that each supplies the same amount of tension. To increase the tension, twist the bands or place two of them together.

In making the frame for the cockpit, as shown in Fig. 4, use ¾ or 13/16 by 2-in. pine lumber. Be sure that the upright frames are braced square when the horizontal pieces are cut and nailed in place.

Wall board 3/16 in. thick is nailed to the frame with 1-in. No. 16 wire nails. Before attaching the top, make the saw cut for the curve facing the cockpit, and let the cowl be somewhat wider than seems necessary, to allow for trimming. Place a supporting block on the underside of the cockpit in place, leaving the other side open to allow for the final adjustments of the banking, rudder, and altitude mechanisms.

The control panel, made of wall board, has on it all of the instruments found on an actual plane. The one shown in Fig. 1 was cut through to receive the dials, but the meters may easily be pasted on after the panel has been cut to shape and painted black. All of the meters are stationary except the bank indicator, which has a movable pointer controlled by the wires connected to the banking mechanism and led over pulleys *N*. This indicator works with the model and shows

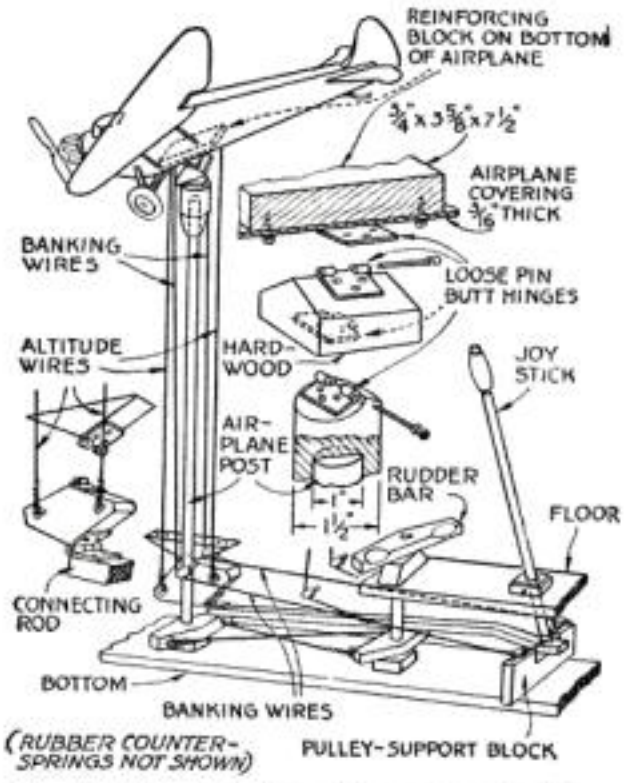


Fig. 2. Assembly of controls and construction of the universal joint and altitude mechanism.

the actual corresponding degree of bank.

All that is left is to complete the model plane and wire the control mechanisms. As this article deals primarily with the controls, only the dimensions and general design of the model are suggested (Fig. 3). Its size lifts the entire project from the toy class and demonstrates serious intent. Any toy plane can be used, but the point of contact with the universal joint must be at the center of gravity of the model.

When the model is in place, connect the banking and altitude wires (see Fig. 4), placing turnbuckles just under the bottom of the plane to allow for adjustment.

Tighten all the wires and make the final adjustments. Try the controls to see if the rubber countersprings provide the correct amount of tension to return the model to a horizontal position when the joy stick and rudder bar are not touched. When the controls are working correctly, nail on the remaining side of the cockpit.

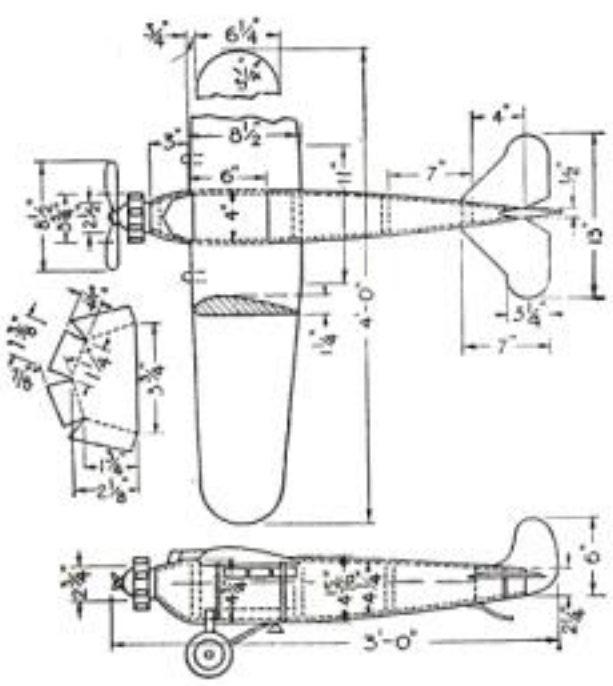


Fig. 3. Suggested dimensions for the model plane. A toy plane can be utilized if desired.

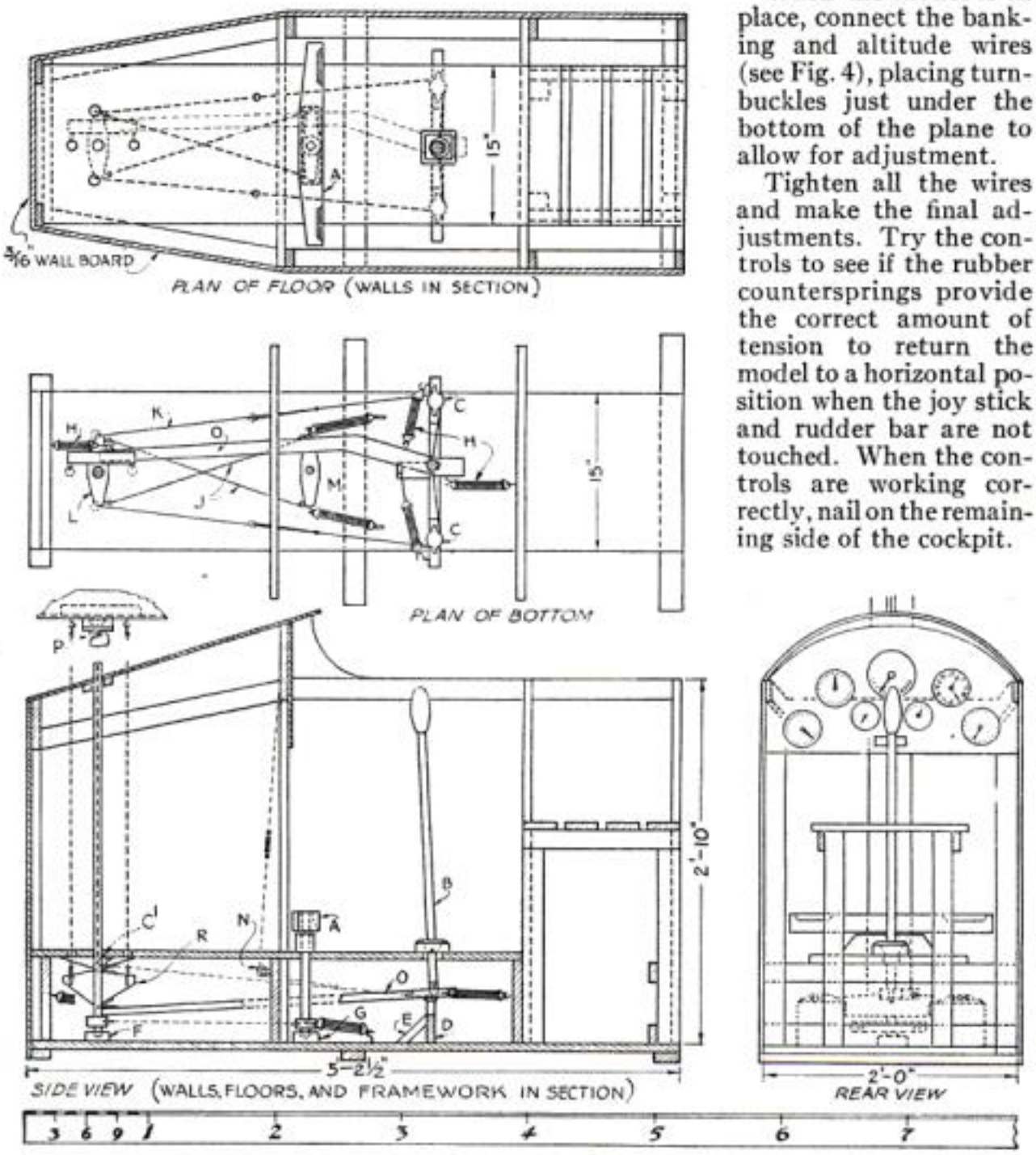
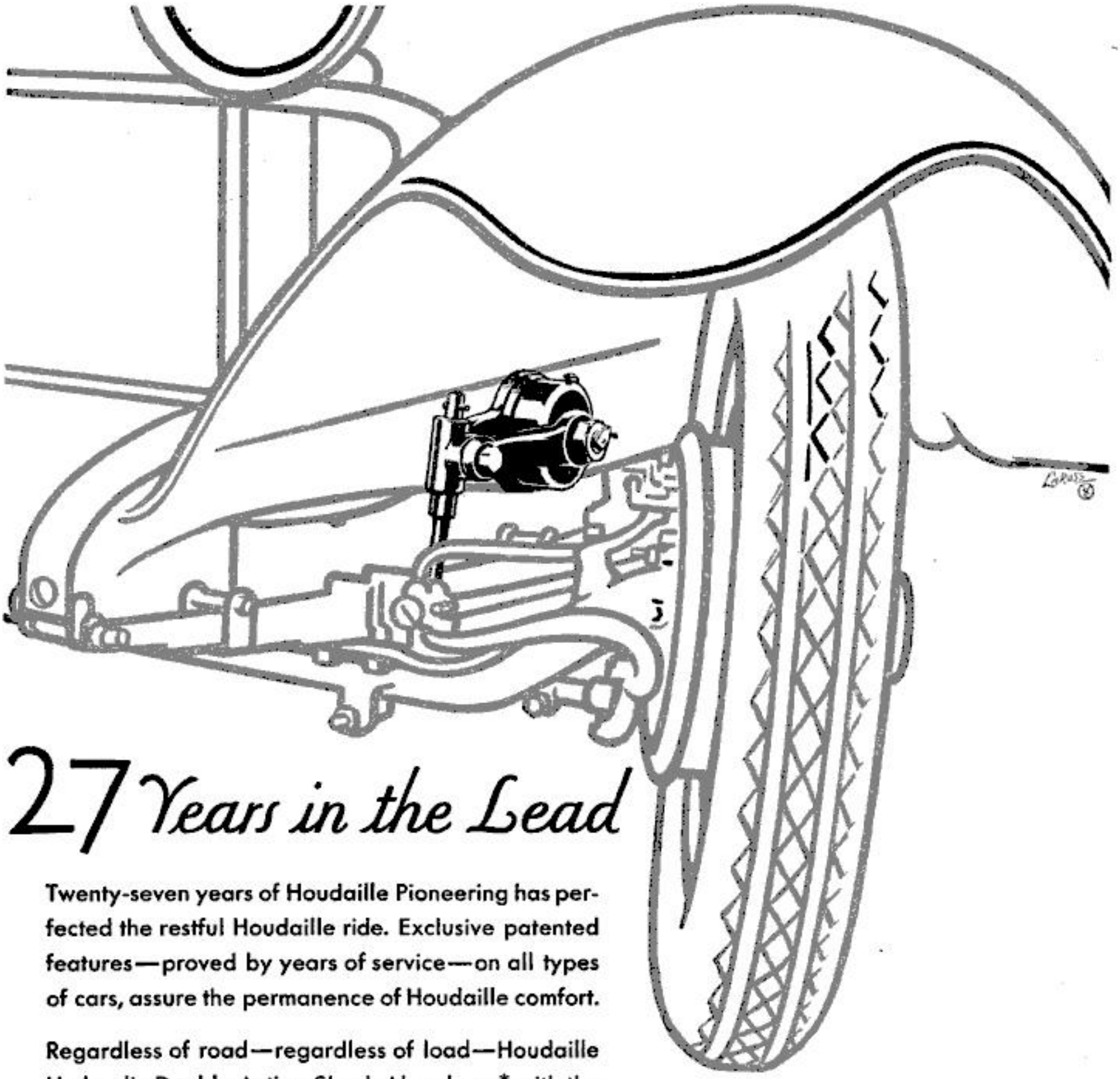


Fig. 4. Scale drawing showing the construction of the cockpit framework, seat, and floor. The plan view of the bottom gives the arrangement of the three separate control mechanisms and wires.



27 Years in the Lead

Twenty-seven years of Houdaille Pioneering has perfected the restful Houdaille ride. Exclusive patented features—proved by years of service—on all types of cars, assure the permanence of Houdaille comfort.

Regardless of road—regardless of load—Houdaille Hydraulic Double Acting Shock Absorbers,* with the needle valve control, provide just the ride you prefer. Their powerful *double action* is automatically proportioned to smooth out any bump at any speed.

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HOUDAILLE
hydraulic double acting
SHOCK ABSORBER

Your car dealer can supply Houdailles at the new low prices—$40, $50, $75 to $100 plus installation. Slightly higher west of the Rockies and in Canada.

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A DIVISION OF HOUDAILLE-HERSHEY CORPORATION

This Colonial console table is an artistic piece of furniture and provides an ideal object lesson in operating a jointer.

Using and Caring for a Jointer

By WILLIAM W. KLENKE

IN THE old Colonial days, no American home was considered properly and completely furnished without a graceful console or card table for the hall. Above this table was probably hung a Chippendale mirror (such as was illustrated in P. S. M., Nov. '29, p. 88).

The design of the table lends itself nicely to the narrow hall as well as one of wider proportions; and, besides, the amateur will find it an interesting piece to construct since it embodies the use of a jointer (small planing machine).

The 4-in. jointer is about as small as is practical and works very well on all general work. The best type jointers are made with three knives or cutters, which are securely fastened in a cylindrical head. The cutters must face the operator, since the machine revolves towards him. There need be no fear about working at this machine as jointers are carefully guarded; however, a few safety rules must be observed in order to avoid any accidents.

Before starting any machine, try all adjustments to make sure that no parts are loose. Revolve the machine by hand to see that the knives swing clear of the throat. All three knives must be set exactly the same distance out so as to make a smooth cut, free from ridges. Never run any wood over the jointer smaller than ½ by 1 by 10 in. For all thin pieces use a block set on top of your work to push the material across the cutters (see the photograph on page 80). Never allow the hand or a finger to rest on the extreme rear end of the wood.

When stock is pushed across the jointer, the pressure is placed on the part of the planer furthest away from the operator. It is good practice to skip over the throat portion of the machine with the hands, moving forward as you go along. Do not take too coarse a cut; it is better to make several finer ones, as it will lessen the chance of the wood's getting away from you. When making any adjustments, always turn the power off.

Step No. 1—Sharpening the Cutter. First, it will be well to study the care and operations of the jointer. Take all knives or cutters out of the cylinder, and sharpen them if dull. Should the cutters be nicked or the bevel rounded, sharpen each knife on the grinder, being careful to keep the edge in a straight line. Then use a fine carborundum stone to whet the cutting edge. This can best be accomplished by placing the cutter flat on a bench top and rubbing the stone over the bevel; now reverse to the flat side and remove the burr with a few strokes, holding the stone absolutely flat.

Step No. 2—Setting the Cutters. Bring both the front and rear bed of the jointer on one line; use a straightedge for this. Place one cutter in at a time and tighten up just a little on the nuts. Work the cutter up and down so that when you revolve the cylinder with your hands, the cutter will just move a wood straightedge. Test both extreme edges. In a like manner, set and test the other cutters. Then tighten all nuts. Turn the forward bed down about 1/32 in. to try out the cut; if you have placed all cutters in accurately, the edge you joint will be a perfect one. Test the edge by jointing a second piece and placing the two edges together.

Step No. 3—The Fence. Most jointers have an adjustable fence so that bevels may be cut. By setting the machine for a coarse cut, you can soon learn to plane a stop chamfer. On many machines it is possible to plane a rabbet; that, however, is something you will have to be shown on your individual outfit.

The steps to be taken in the construction of the console table, which can be made of Mexican mahogany or stained birch or maple, are as follows:

Step No. 1—Legs. On the lathe, turn all six legs to the design.

Step No. 2—Rails. Joint all edges on the jointer and rip to the proper width on the circular saw; then joint this sawed edge. Tilt the saw table to the proper angle and cut the ends of all rails, using a combination saw in order to obtain a smooth cut. (The use of the circular saw was described in P. S. M., Nov. '29, p. 88.)

Step No. 3—Joints. If you have a chuck for your lathe, you can bore all holes for the dowel joints on the machine. Glue false ears on all rails in order to obtain a gripping surface for clamp. (Explained in P. S. M., Nov. '29, p. 88.)

Step No. 4—Sanding. Before assembling any parts, hand dress and thoroughly sand all parts of all pieces. Start with No. 1 sandpaper and finish with No. 0. The top may be fastened to the body part by panel irons or by screws driven up from the inside at an angle. Remove all excess glue with a chisel and again clean up with sandpaper; slightly round all edges with No. 00 sandpaper before staining.

Step No. 5—Assembling. Glue the two short ends together first and then assemble the short front rail with the two legs; this leaves the back rail and the two slanting

Left: Setting the jointer fence at an angle prior to cutting a bevel. Above: Using a straightedge to bring both beds up even and allow the cutters to be set. Right: One of the jointer cutters and the strip which holds the fastening screws removed from the cutter drum to show construction.

The builder of your radio set designed it to use these tubes

If you visited the factory where your radio set was built you would see RCA Radiotrons everywhere used for precision testing.

Manufacturers know there is no finer vacuum tube made. They construct their sets so as to exactly match RCA Radiotrons. Inferior tubes—imitations of genuine Radiotrons—mean inferior performance.

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ALFRED MARCHEV,
President and General Manager, Temple Corporation of Chicago, *says:*

"In perfecting our Templetone radio receiver we sought the vacuum tube which would do full justice to its remarkable reception and tone quality. Our laboratory tests convinced us that RCA Radiotrons produced the best results. We always recommend them for Templetone sets."

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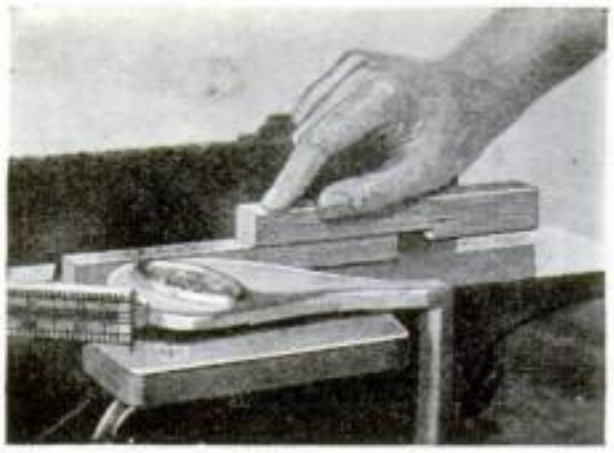
Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

rails to be glued in the next operation. When these parts are glued and set, assemble the rest of the table.

Step No. 6—Top and Headpiece. Use the jig or band saw for the curve on the headpiece. The top can be cut on the circular saw and jointed on the jointer. If you have a shaper, run the edge by machine; otherwise, work it out by hand methods.



For running small pieces on a jointer, use a wooden safety block instead of your fingers.

Step No. 7—Finishing. If you have chosen Mexican mahogany as the material, either of the two methods given below can be followed.

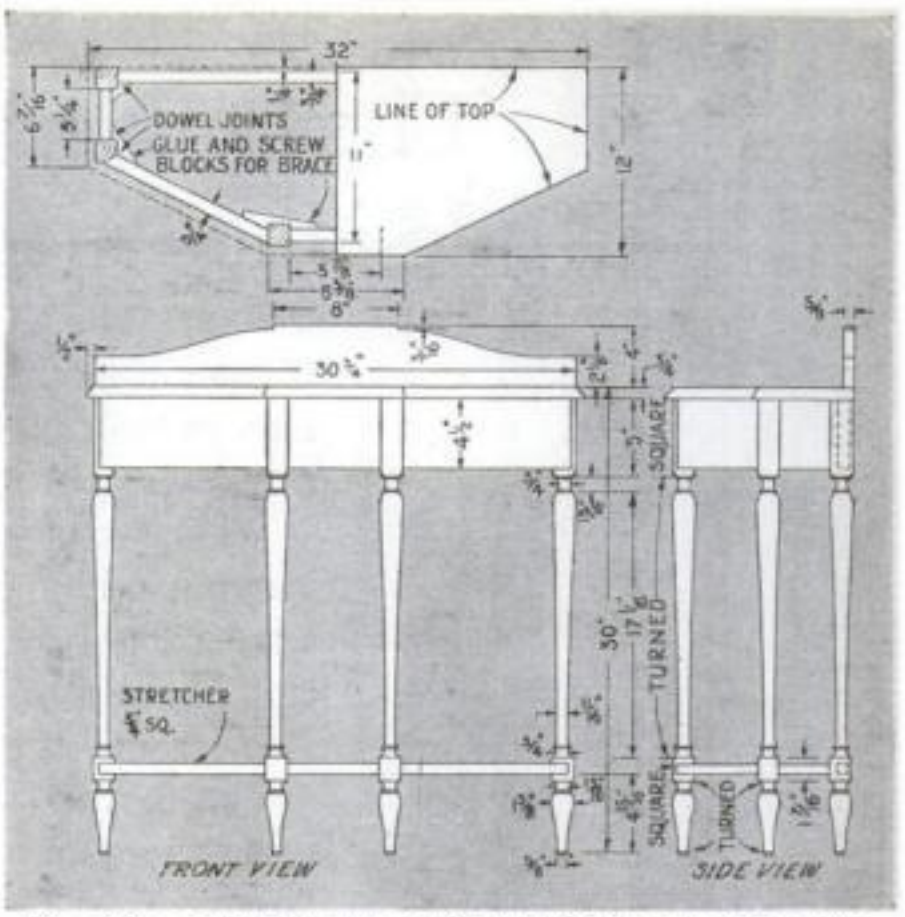
Buy a high-grade mahogany water stain powder and dissolve it according to directions, or get a prepared wood stain or dye of first-class quality. Apply a liberal coat with a brush and allow the stain to dry thoroughly. Put on a very thin coat of white shellac and sandpaper when dry with No. 00 sandpaper. You are now ready to apply two coats of paste wood filler, following the directions given on the can. Allow at least two full days after the last coat for the filler to harden (a longer time is even better). Apply three thin coats of white shellac, rubbing each coat when dry with No. 00 sandpaper, and the last coat with a mixture of crude oil or machine oil and fine pumice stone powder. If you have a spraying outfit, spray clear lacquer on, instead of shellac.

For the second method, purchase bichromate of potash crystals at any drug store and make a saturated solution in water. Dilute one part of saturated solution with four parts of water and stain the wood with it. When it is dry, rub lightly with No. 00 sandpaper. Next apply a coat of ready mixed penetrating mahogany stain or wood dye. Then use filler and shellac as before, or filler, one coat of thin shellac, and finish with two coats of varnish.

If you have used birch or maple and wish to imitate mahogany, it can be successfully accomplished by applying one coat of a good make of prepared mahogany stain and then following the other steps as given above.

Finished in an amber color, maple may be made to look like an antique piece. Two methods for this type of finish are the following:

Apply one coat of the proper amber shade of water stain and proceed to finish as mentioned above for mahogany, with the exception that maple, being a very close-grained wood, will require no wood filler, as the shellac fills any very small pores such as are found in maple. The second method is to give the entire project a coat of oil walnut stain and when this has dried, rub the high-lights through almost to the bare wood with No. 00 sandpaper to give it a worn appearance. Then shellac and finish as mentioned in the directions given above.



Plan of the old Colonial console table showing the construction of the top frame and the location of the corner braces and stretchers.

This article is the sixth of a series in which Mr. Klenke, through the courtesy of various manufacturers, is demonstrating the use of many of the new motor-driven home workshop machines of both combination and individual types now used extensively.

How to Make a Miniature Christmas Village

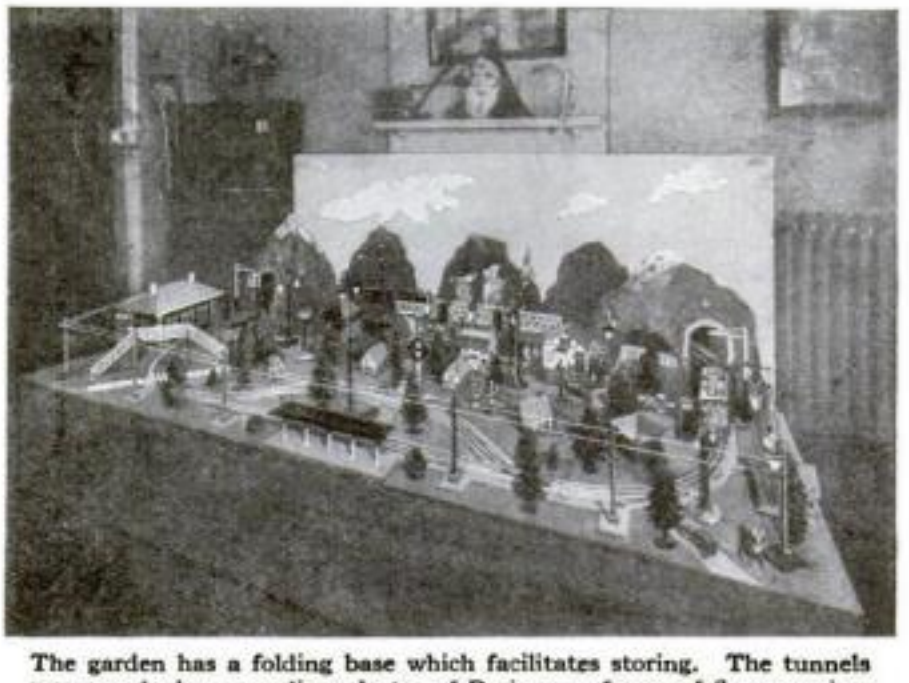
THE Christmas village or garden illustrated, with its starry sky, realistic mountains, and folding platform and foundation, is simple in construction. It can be modified from year to year and there is no sawdust or sand to cause the housewife grief.

The platform and base are both hinged to facilitate storing. The platform is made by hinging two 2½ by 8 ft. pieces of plywood together along their long sides. The frame of the foundation is made of any available lumber, such as 1 by 3 in. shingle lath, and is hinged on two opposite sides for convenience in storing. Two hooks and eyes placed at the hinges make the frame rigid while in use. The platform is placed on the foundation in such a way that the hinges of each lie on different center lines.

The sky is painted on a 4 by 8 ft. wall board. It is light blue at the top and darkens as the bottom is approached. The clouds are cut from wall board and glued on the sky board.

The mountain profiles in the back of the garden are cut from plywood and painted, and the tunnels are built up by spreading plaster of Paris on fly screening. A rocky surface can be obtained by sticking small rocks or cinders in the plaster while it is still soft. After the plaster has thoroughly dried, it should be primed and then painted to represent a scene with trees and rocks and a snow-capped peak. The rougher the job of painting, the more realistic will be the final result. Use tube paint and put the finish on with a dry brush.

Arrange the houses and tracks and then lay out patterns for the grass plots, which are cut from wall board and painted green to represent grass. Paint the top of the platform a brown or slate gray and nail the grass plots in place.



The garden has a folding base which facilitates storing. The tunnels were made by spreading plaster of Paris on a frame of fly screening.

The sky can be lighted by placing Christmas tree lights in the back of the mountain profiles, blue and red making a good combination.

All wiring is concealed under the platform along with the transformer and control switches. The street lights and sky lights should be connected in series in sets of nine bulbs each and connected right into the house line. The automatic signals, however, are connected directly to the railway track.—A. McCARRICK.

AMAZING RECORDS

in Dust Prevention Tests among leading furniture polishes

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PROMINENT CHEMIST FINDS JOHNSON'S WAX POLISH REDUCES DUSTING 50%

HENRY W. BANKS, III

MAKE TESTS SHOWN HERE —FULL-SIZE 25c CAN FREE FOR DEMONSTRATION

The idea of putting furniture polishes under the microscope has brought to light one of the most important household discoveries in recent years! A fact of vital significance for those to whom dusting is never-ended drudgery.

Fifty per cent of the average household dusting can now be eliminated. A chemist of national reputation, Henry W. Banks III, makes this encouraging statement as a result of his recent six months' experiments:

"Our tests show conclusively that dust does not cling to furniture polished with Liquid Wax. Under average household conditions fifty per cent less dust accumulates on waxed surfaces than on furniture polished with other polishes. Dust that remains on the wax stays on top, does not become imbedded, and is easily whisked off. Succeeding experiments confirmed these original findings."

Will you, with the certainty of eliminating half the dusting in your household, take the trouble of sending for a free 25c can of Liquid Wax to make this home demonstration? Just use coupon. S. C. Johnson & Son, "The Interior Finishing Authorities," Racine, Wis.

FOR HOME CARPENTERS Johnson's reliable Wood Dyes settle the ticklish question of the proper finish. *In all colors.* Bring out the natural beauty of the grain. Dry quickly. Never smudge or rub off. Enable you to have the beauty of the finest hardwoods on inexpensive softwoods. Guaranteed not to raise the grain. At hardware and paint stores.

●

Four experiments that ended household dusting drudgery

UNDER THE MICROSCOPE

Note dry hard film of Johnson's Wax with dust particles (half as many as on right) lying *on top*, not imbedded. Companion photomicrograph shows dust particles imbedded in film of ordinary oily polish, held like flies on fly paper.

THE WEIGHT TEST

Not content with this evidence alone, Dr. Banks verified the findings of the microscope with three other tests as shown here and below. These unretouched photographs show the actual amount of dust collected by three panels, all of the same size, all exposed to dust the same length of time in the same room. The first, polished with Wax, collected less than half the dust that accumulated on either of the others which were polished with ordinary polishes.

THE "BLOW" TEST

A mechanical test in which an electric fan was used to "blow" dust on three panels polished respectively with Wax, Polish A, and Polish B. Test proved conclusively that dust does not cling to waxed surface.

THE "DUST CLOTH" TEST

A convincing test that is easy to make. Cloth on the left was used to "dust" a waxed panel. Cloth on right was used on panel polished with Polish A. Both panels were exposed to the same amount of dust for the same length of time.

S. C. Johnson & Son, Dept. PS1, Racine, Wis.

Gentlemen: Please send free 25c can (not a sample) of Johnson's Liquid Wax for dust demonstration and illustrated booklet on the new care of floors and furniture.

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(Please print)

Address_____

City_____ State_____

Useful Kinks for the Car Owner

A Prize of $10 Is Awarded Each Month for the Best Idea or Suggestion of Practical Value to Motorists

CARRYING water in a hat, shoe, or even in the bowl of a headlight are possible methods whereby water can be put into the radiator in an emergency. But it is much more satisfactory to do the job by the ingenious method shown in Figure 1. The device consists of a three-foot piece of discarded inner tube. One end is folded back on itself and bound tightly by a rubber band cut from the remaining part of the tube to one end of a thirty-inch piece of broomstick. The other end of the tube is rolled back on itself, like a cup, and the turned end stretched over the free end of the stick.

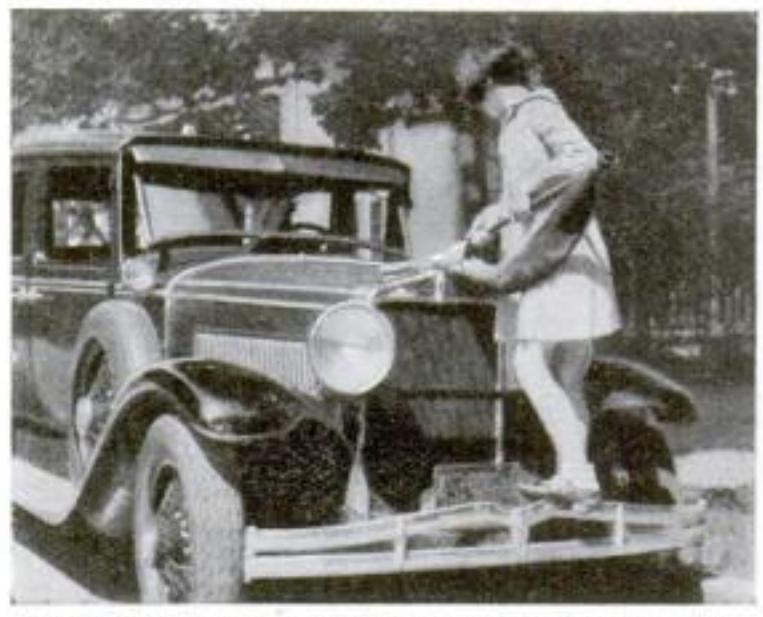


Fig. 1. A discarded inner tube fastened to a broomstick serves as an emergency bucket for filling the auto radiator.

The capacity of the bucket, if a five-inch tube is used, is approximately eight quarts. The use of a stick in this way makes the improvised bucket easier to carry, permits control while pouring, and holds the tube extended to simplify filling in either standing or running water.

Drying Ignition Wires

Fig. 2. Drying high tension wires with powder-coated rag avoids short circuits from moisture.

A SHORT in the high tension wires leading to the spark plugs, caused by moisture, usually occurs where the wires are clustered together.

When this happens, dry the wires, one at a time, as in Figure 2, with a cloth on which is placed a generous amount of either soapstone powder or face powder, preferably soapstone. In drying the wires entering the distributor cap be careful not to remove more than one wire at a time unless it is well understood how to replace them.

Keeping the wires and the outside of the distributor cap exceptionally clean and using soapstone in the manner described will result in keeping the rubber insulation in good condition and no trouble will be experienced from rain. Of course, this suggestion applies only to ordinary rubber-covered high tension wire. Special high tension wire covered with varnished fabric should not be treated in this way. Such wire should be wiped with a clean dry cloth only.

Hood Scratch Preventers

THE enamel on the auto radiator and cowl frequently is scratched by raising and lowering the hood carelessly. Such scratches can be prevented by attaching small leather "fenders" to the corners of the hood, as shown in Figure 3. They are made from sheet leather about two inches square, folded over as indicated, and riveted to the corners of the hood. Besides preventing scratches when the hood is raised or lowered these fenders also decrease hood rattle when the hood clips are loose.

The Prize Winner

A WOODEN block and two ordinary nails can be fashioned into the handy spark plug tester shown in Figure 4. It is the idea of Carl Rutledge of Wauna, Ore., and wins this month's prize of $10. First bore the hole as indicated, and then drive two nails through diagonally so that their points will approach within an eighth of an inch of each other. The nails are set at such an angle that the heads rest on the spark plug terminals.

The higher the engine's compression ratio, the greater should be the gap between the nails to test the spark plugs fairly. One eighth of an inch will do under average conditions. If the spark jumps between the nail points it is an indication that the spark plug is not short-circuited or carbonized.

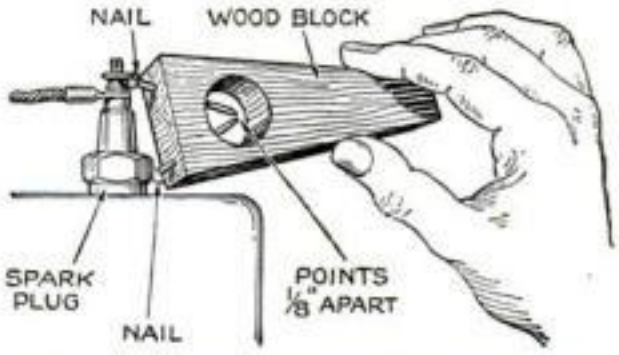
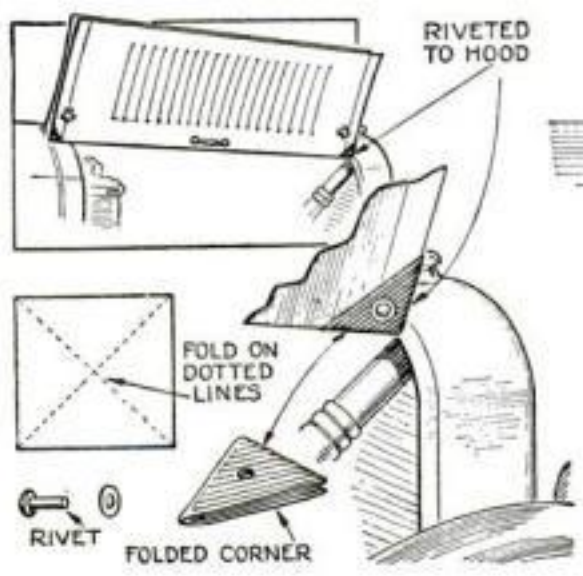


Fig. 4. Testing a spark plug with nails driven in block. The spark jumps between nail points.



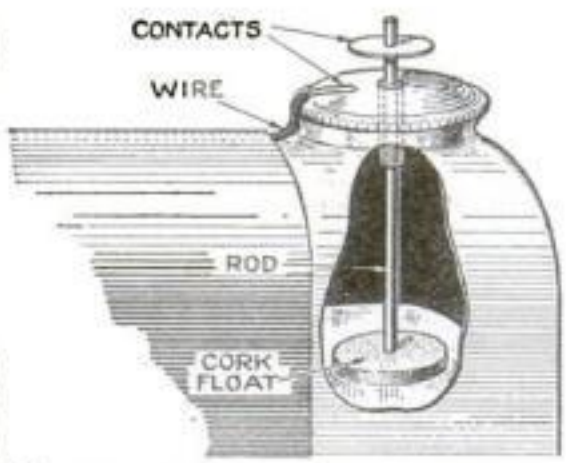


Fig 3 (left). How to make and attach leather hood "fenders" to prevent scratches. Fig. 5 (above). An indicator to warn when water in radiator is low.

Water Level Indicator

THE indicator illustrated in Figure 5 gives definite warning when the water level in the radiator gets too low. This diagram shows only the principle of the device for the contact must be arranged to suit different radiator caps. A cork float on the end of a rod should be used and a short length of copper or brass tubing should be soldered in place against the hole in the radiator cap to act as a guide and keep the float rod in a vertical position.

A disk on the upper end of the rod makes contact with a wire and thereby grounds it when the water level goes too low. One terminal of a double contact indicator bulb on the dash should be connected with the current supply and the other terminal with the wire that makes contact with the float disk. If the cap unscrews, arrange the contact wire so that it can be swung out of the way. If the cap turns back on a hinge the contact can be fastened to a piece of fiber or bakelite and connected by a piece of flexible wire.

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By changing to the new Mobiloil Arctic, your every winter lubricating problem will be solved. This unique winter oil—made for *your* car by the world's largest lubrication specialists—flows easily *at zero*, and has the correct body under winter temperatures to guarantee quick, easy starting and at the same time give rich, protective lubrication when your engine gets hot. In combining these characteristics Mobiloil Arctic stands alone.

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It shows the correct grade of Gargoyle Mobiloil for certain prominent cars. If your car is not listed below, see complete Mobiloil Chart at your Mobiloil dealer's.

Follow winter recommendations when temperatures from 32° F. (Freezing) to 0° F. (zero) prevail. Below zero use Gargoyle Mobiloil Arctic (except Ford, Models T, TT, use Gargoyle Mobiloil "E").

NAMES OF PASSENGER CARS	1929 Engine		1928 Engine		1927 Engine		1926 Engine	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Auburn, 6-66	BB	Arc.	BB	Arc.	BB	Arc.	A	A
" 8-cyl.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" other models	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
Buick	BB	Arc.	BB	Arc.	BB	Arc.	BB	Arc.
Cadillac			A	Arc.	A			
Chandler Special Six	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" other models	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Chevrolet			A	Arc.	A	Arc.	A	Arc.
Chrysler, 4-cyl.								
" Imperial 80 and Imperial	BB	Arc.	BB	Arc.	A	A	A	A
" other models	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Dodge Brothers	A	Arc.	A	Arc.				
Durant	A	Arc.	A	Arc.				
Elcar, 8-cyl.	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
" other models	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Erskine	A	Arc.	A	Arc.	A	Arc.	A	A
Essex	A	Arc.	A	Arc.				
Ford, Model A	A	Arc.	A	Arc.	E	E	E	E
" Model T					BB	BB	BB	BB
Franklin	BB	Arc.	BB	Arc.	BB	Arc.	BB	Arc.
Gardner, 8-cyl.	BB	Arc.	BB	Arc.				
" other models							A	A
Hudson	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Hupmobile	BB	Arc.	BB	Arc.	A	Arc.	A	Arc.
La Salle	BB	Arc.	BB	Arc.	BB	Arc.		
Lincoln	BB	Arc.	BB	Arc.	BB	Arc.	BB	Arc.
Marmon, 8-cyl.	A		A	A	A	A		A
" other models		Arc.	BB	Arc.	A	Arc.	A	Arc.
Moon	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Nash, Adv. & Sp. 6	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
" other models	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Oakland	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Oldsmobile	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Packard	A	A	BB	A	BB	A	BB	A
Peerless, 72, 90, 91	BB	Arc.	A	Arc.	A	Arc.	A	Arc.
" other models	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Pontiac	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Reo	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Studebaker	A	Arc.	A	Arc.	A	Arc.	B	Arc.
Whippet	A		A		A			
Willys-Knight, 4-cyl.		Arc.		Arc.		Arc.		Arc.
" 6-cyl.	BB		BB		BB		BB	

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Maintaining a Model Railway

Oiling Electric Locomotives — Type of Lubricant to Use and How to Apply It — Keeping Tracks and Switches Clean

By FREDERICK D. RYDER, JR.

THE importance of the proper lubrication of fast moving machinery has been dinned into everybody's ears so frequently that it seems unnecessary to repeat the advice as applied to model electric railways.

Bearing pressures are relatively light, bearing speeds at some points are quite high, and the lubricant that cuts friction to the minimum under such conditions is a very light, high-grade machine oil such as would be suitable for typewriters, sewing machines, and other similar light machinery.

An astonishingly small quantity of oil will perfectly lubricate the armature bearing. Any excess oil simply smears out around the bearing where it can do no good and serves only to collect dust.

The armature bearings of the motor and the gears should be sparingly lubricated at least once for each hour of running. The drivewheel axle bearings should be lubricated in the same way after each two or three hours of running. The tiny bearing at each end of each roller on the collector plate should be lubricated just enough to keep it from running absolutely dry. Any excess oil on the collector roller bearings will work down on the rollers and smear all over the third rail.

If you are fortunate enough to own locomotives fitted with the new style motors that can easily be taken apart, it is a good idea to pull them completely to pieces every two or three months and carefully clean the excess oil and dust from each part.

A broom straw or a piece of fine wire is the best article to use in applying oil to the bearings and gears; Fig. 2 shows a piece of wire being used for this purpose. A tiny drop of oil can be picked up on the end of the wire and applied just where it is needed.

The axles of each passenger and freight car should be sparingly oiled once every month or two. The only other thing on the model railway that requires lubrication is the turntable, the gearing of which may be oiled at very long intervals.

When, many years ago, the pioneer railroads first began to carry passengers and traffic in a commercial way, the crude locomotives of those days frequently broke down. However, it is a curious fact that the majority of accidents on those primitive railroads were due to track failure. Instead of the immensely strong rails of heavy steel now in use, the first locomotives ran on rails made of thin strips of strap iron insecurely bolted to wooden stringers. Every so often a piece of strap iron would come loose, curl up, and poke a hole in the boiler of the locomotive.

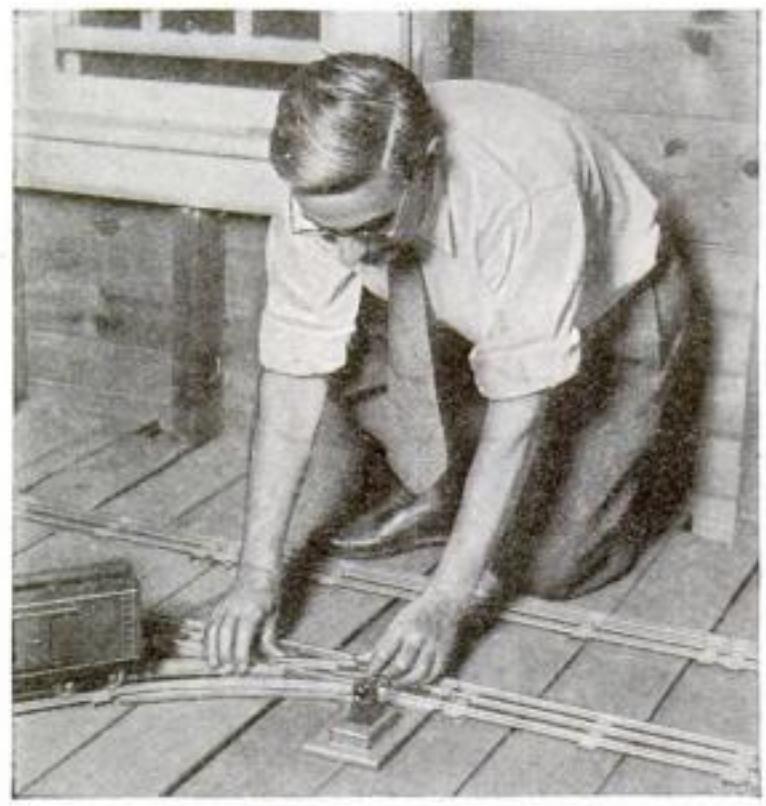

Fig. 1. The curved rail on switch plates should be inspected frequently and bent back into place if necessary.

Even today, a vital point of difference between one of our crack railroads and a backwoods branch line is in the quality of the roadbed.

Each section of model railway track as it comes from the factory is exactly straight if it happens to be a straight section, or a perfect segment of a circle if it is a curved section. But even the most perfect track has to be carefully laid (P. S. M., Jan. '29, p. 76).

On my own model railway, track laid on the floor over five years ago is still in use and shows only trifling wear.

Some oil is bound to work down on to the track from the wheels and on to the third rail from the collector rollers. Dust settles and in time the rails become coated with a gummy film that reduces the pulling power of the locomotives and interferes with the flow of the electric current.

If more than an occasional spark can be noted under the collector rollers as the locomotive speeds around the track, it is conclusive evidence that the rails need cleaning. Plain rags applied with plenty of "elbow grease" will serve to clean the rails, but a quicker and more satisfactory job can be done with a gasoline-soaked rag.

A word of warning—whenever you use gasoline, either to clean the commutator of a motor or to clean the rails, *be sure* to wait a considerable time before operating a train. A spark at the commutator or collector rollers is likely to cause an explosion or a fire that will prove much too realistic even for the most ardent model engineer. Because of the fire risk it is wise to use one of the unburnable cleaning fluids on the track. Lighter fluid is, however, best for the commutator because cleaning fluid may contain a chemical injurious to the insulation of the armature winding. The fiber insulation of the third rail is, of course, immune to such fluids.

Switches should be cleaned along with the rest of the track. The electrical mechanism that operates the switch is purposely inclosed in a metal case in such a way that you can't get at it. If an electric switch fails to operate, first try a slightly higher voltage. If it still refuses to function, send it back to the factory.

After a switch has been in use for some time, especially if you have operated heavy locomotives through the curve of the switch at high speed, trouble may be experienced with derailments of the cars. This is due to the bending of the curved rail on the movable plate by the weight of the locomotive as it hits the switch. The remedy is to bend the rail back into place as shown in Fig. 1.

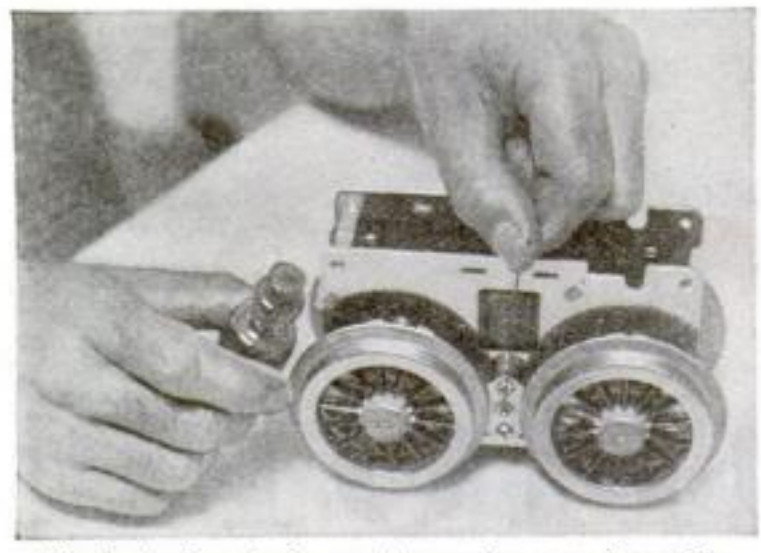

Fig. 2. A piece of wire, or a broom straw, can be used in applying oil to the motor bearings and various gears. Choose a very light, high-grade sewing machine oil.

THIS is the second of a series of articles by Mr. Ryder on maintaining a model railway. The next installment, scheduled for early publication, deals with painting. Readers who have model railroad problems about which they wish advice may write Mr. Ryder care of POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York.

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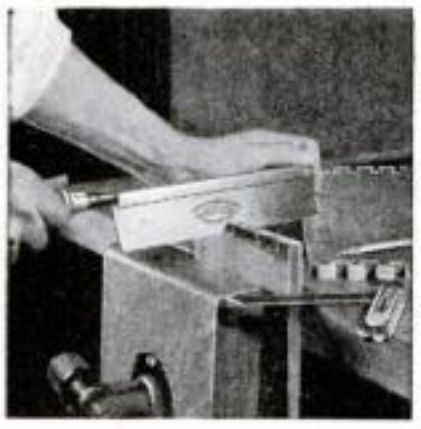
To make the useful articles shown in this valuable book you will, of course, want Disston Saws, Tools, and Files. There is no substitute for Disston quality.



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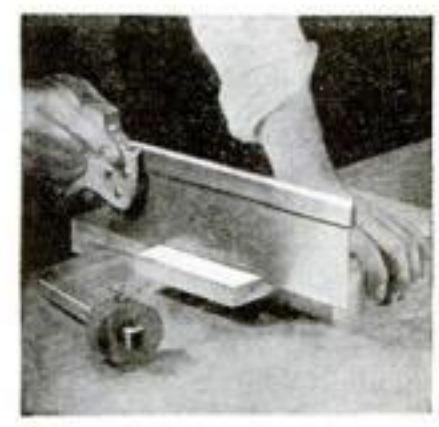

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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Chip Carving for the Amateur

By DAVID WEBSTER

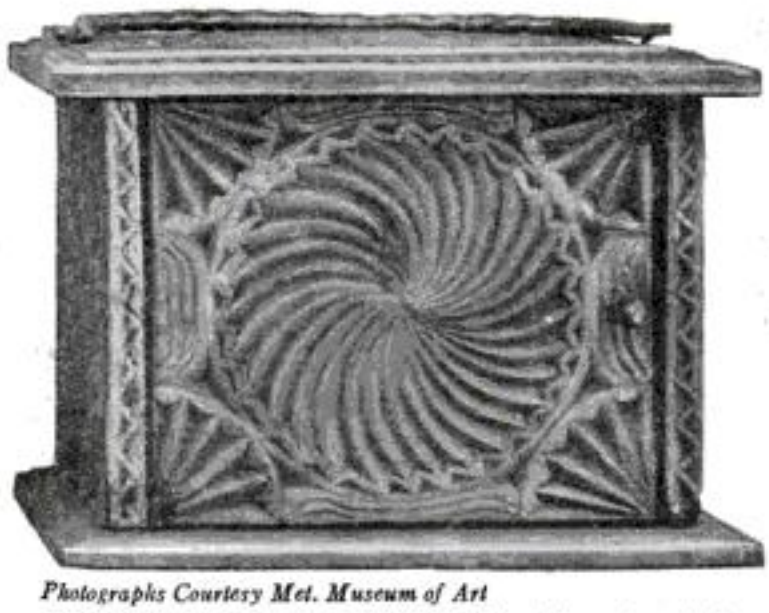
CHIP carving, although the easiest form of wood carving, is also one of the most decorative. Many people associate chip carving with small triangular cuts and do not realize that beautiful sweeping curved cuts and embellishments can also be made.

The designs adaptable to chip carving range from the very simple to the highly complicated and may be developed and refined to any degree the worker's skill will justify.

Only a few tools are required for the most elaborate chip carving, of which the knife is the most important. It may be used by one or both hands, the tool itself being held in about the position indicated at *a* and *b*, and moved in the directions suggested by the arrowheads. Any amateur craftsman who can use tools with fair skill will have no trouble in sensing the correct method after a little practice. The position of the knife at *a* is correct for making the vertical cuts which define the outlines. These cuts also limit the depth of each figure and make it possible for the flat cuts to take the wood out clean without tearing or splintering. At *b* is shown the flat cut by which the wood between the vertical cuts and the lines at *c* is removed. The tapering point of a sharp jackknife blade will be necessary to cut out small places as at *d*. Often the skew chisel may be used to advantage in a heavy cut instead of the knife.

Veining tools are used in the more advanced work, for in many cases a definite line is needed as a starting place to emphasize border lines and to separate masses or different parts of the design as at *e*. In making a straight line the veining tool should be guided by a wood rule; with a little practice the tool can be guided to make cuts of uniform width and depth.

The worker must realize that sharp tools are of the first importance and that time spent in keeping them in perfect condition will be more than justified by the pleasure and satisfaction resulting from their use. The tools may be kept sharp by using an oilstone for straight edges and slip stones for curved edges. The carborundum oilstone shown is coarse upon one side and fine upon the other, while the slip stones are of fine grain throughout. The coarse side will act as a grindstone in keeping the edge just the right shape. The bevel of the edge must be maintained; to do this, hold the entire bevel in perfect contact with the stone. The inside of the veining tool may be stropped by using a leather shoe string; grasp the tool with one hand, hold the shoe string in the V-groove or the gouge with the thumb while the other hand draws it through. A groove made in the leather strop by one of the veiners will strop the outside of the bevel.



Photographs Courtesy Met. Museum of Art

More difficult designs were used by the old masters, but the methods were almost the same as those described.

A round-faced mallet is a necessity in making some of the more difficult cuts, as the tool may be controlled far more effectively when tapped gently with a light mallet than is possible by hand control alone.

The hand screw and clamp or other equally efficient means are necessary to hold the work rigidly upon the table or bench, for if the worker tries to hold the work with one hand and cut with the other, he is due for a bad cut sooner or later.

Perhaps the home worker may think that mention of the grain of wood is superfluous, but if care for the grain is important in the use of ordinary tools, it is vastly more so in carving.

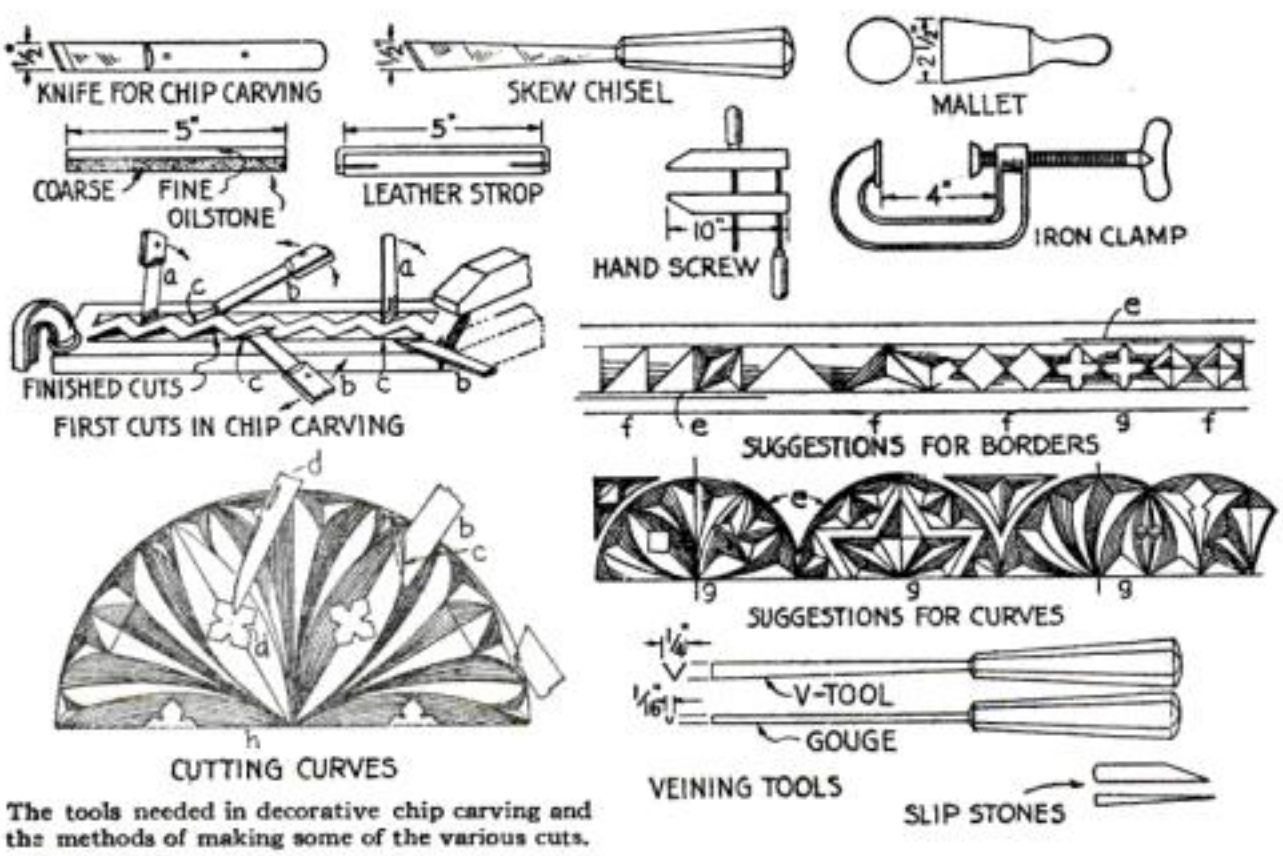
Any worker will instinctively select soft, straight-grained wood free from blemishes for all sorts of carvings; yellow whitewood and red gum are excellent woods. White pine is too soft for amateur work, as it does not furnish enough resistance and demands exceptionally sharp tools. Maple is a splendid wood for the advanced worker but rather hard for the beginner. Soft red oak is perhaps more interesting than either of the above woods, though it is rather splintery for the novice.

Many chests have been unearthed that bear chip carved embellishments and decorations.

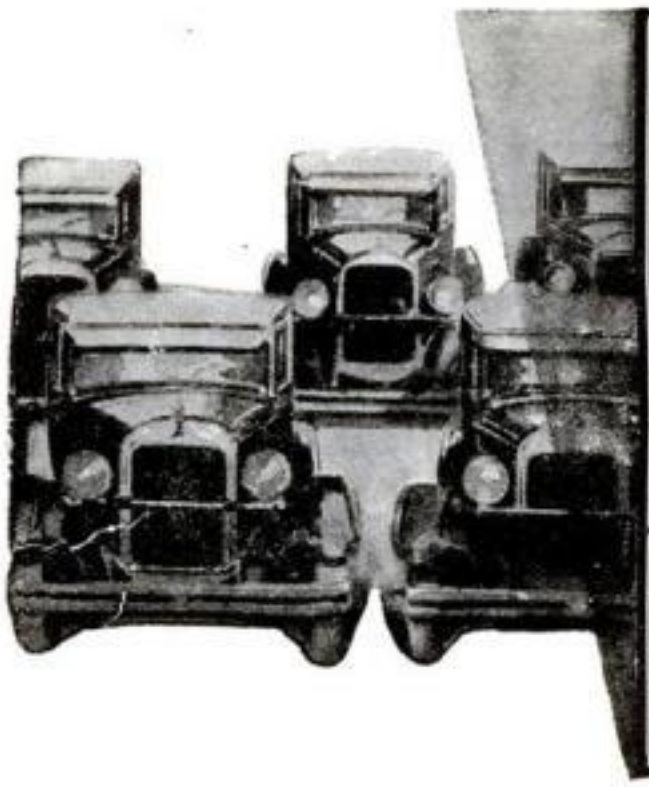
Do not make the first attempt at carving upon a piece of wood to be used in the project; instead select a similar piece, lay out the design, and practice.

The first thing is to follow lines closely; the next, and equally important, is to make each cut clean, with no suggestion of torn wood. The most common error in the actual cutting lies in making the flat cuts too deep; the next, in making adjoining cuts of different depths.

In selecting designs for chip carvings give preference to the bolder type of designs similar to those suggested at *f* and *g*, at first. Dark stains aid in giving an appearance of age to the carvings. Repeated coats of oil, if well rubbed, will impart an excellent tone. Shellac, well rubbed with pumice stone and oil, and afterward treated with wax, makes perhaps the best finish of all.



The tools needed in decorative chip carving and the methods of making some of the various cuts.



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Odd Shop Uses for Common Materials

By HENRY SIMON

By smoking the work and trimming the soot off with a tool, a cut of one ten thousandth can be taken.

MANY small shop operations can be accomplished with greater ease if the worker knows how to make the best use of familiar, everyday materials. Who would believe, for instance, that such things as sealing wax, cement, and paraffin have a place in the average shop. They have, and the success of many important operations often depends on knowing some little kink made possible by the physical characteristics of one or more of these very common materials.

Since sealing wax has been mentioned, let us start with that. How can the mechanic have any possible use for it? One the writer found is for covering the heads of adjusting screws that are not to be disturbed, and yet must be readily adjusted when necessary. At *A* in Fig. 1 it is used to seal a limit gage, with the help of an inexpensive special stamp. The wax surface should be about half a hole diameter below the metal. This is different at *B*, where sealing wax is merely employed for protection from rust and dirt, and is therefore flush with the metal. At *C* the wax serves to plug a small hole in the place of wood or metal, the latter often being hard to remove. For such purposes, sealing wax is excellent, as long as the parts are not heated appreciably.

Paraffin is indeed one of the handiest substances in a shop. At *A* in Fig. 2 it serves as a lubricant in tapping or reaming small holes in aluminum. It is as good as kerosene for this purpose, and is not as wet and messy. As shown at *B*, the heated paraffin is daubed into the holes to be finished, with a small stick, and is allowed to solidify before starting work. Very different applications are those at *C* and *D*, such as making a drawer run or a wood saw cut. It will do both without causing the one to stick in damp weather, and the other to mess up the wood as oil is sure to do.

Paraffin is one of the best materials for waterproofing wood, provided the wood is not to be exposed to very warm water. Unlike varnish, it provides complete protection and does not crack. Small pieces may be soaked in melted paraffin as at *E*, while it may be applied to large ones with a flatiron as at *F*. A very different use is that at *G*. The next time you have some small, fussy mechanism to examine, freeze the whole thing in paraffin. Individual parts can be quickly cut out with a hot wire. When the work is done, all that is necessary is to melt the paraffin out and wash off the remainder with gasoline.

A stearin candle is a good substitute for some of the uses of paraffin, and a handier one to carry. Moreover, it has the advantage of making the finest kind of smoke, for which there is no substitute when used as shown at top of this page. Any one who has ever tried it, knows how difficult it sometimes is, in stepping or recessing a part by a specified accurate depth with the dial, to know when the tool is just at the reference surface, and yet avoid touching the surface. By lightly smoking the work with a candle while it is slowly revolving, a delicate coat of soot is formed, which may be trimmed off with the tool like metal until just a visible shade is left. That shade is about equivalent to about one-ten thousandth of an inch. Try this trick instead of using up your nerves the next time, and you will always be using it.

HARD cup grease is equally good for holding small parts so they won't move when they want to, and will move when you want them to. An open ball bearing as at *A* in Fig. 3—now no longer very frequently met with—is a case in point, especially when it must be assembled in any position other than the vertical. A similar use for hard grease is shown at *B*, where screws are kept from dropping out of some part into the machine. Wherever light parts must be held together or stuck on temporarily and kept from moving or dropping, hard grease is a candidate for the job, as suggested by only one out of many cases at *C*.

From grease to oil is but a step. Oil is useful for knocking out a bushing by hydraulic pressure as at *A* in Fig. 4, provided the bushing hole is blind and a very snugly fitting plug is used. Cup grease should be used when the bushing is in a horizontal or head down position, as at *B*. A good sized can or pail beneath the product chute of a screw machine as at *C*, kept continually filled with oil by the cooling oil circulation, makes an excellent oil cushion for heavy parts that are being made and should not be dented. This scheme works well where there are not many large chips, as in some of the parts shown at *D*.

Portland cement, lime, and gypsum may at first thought seem out of place in a toolroom. Yet it pays to keep them on hand. Slaked lime is one of the best media for annealing steel parts, as suggested by *A* in Fig. 5. A small box of unslaked lime in the tool drawer as at *B*, keeps it free of moisture and prevents the tools from rusting. Gypsum is good for holding pieces of work for light machining jobs, as suggested at *C*. Cement may be employed to make a regular working machine bed or base that will give good service for years. *D* shows a simple example. The only requirements are that the section be comparatively heavy, and that proper reinforcing is used. An advantage over cast iron is the fact that bearings and other parts can be accurately cast in place without machining, by lining them up as at *E*.

FOUR more common materials are rubber, leather, composition board, and fiber—as shown in Figs. 6, 7 and 8. A stout rubber band makes a fine belt for a delicate drive, as at *A*. Rubber bands of various sizes are often an excellent substitute for a tension spring, and as indi-

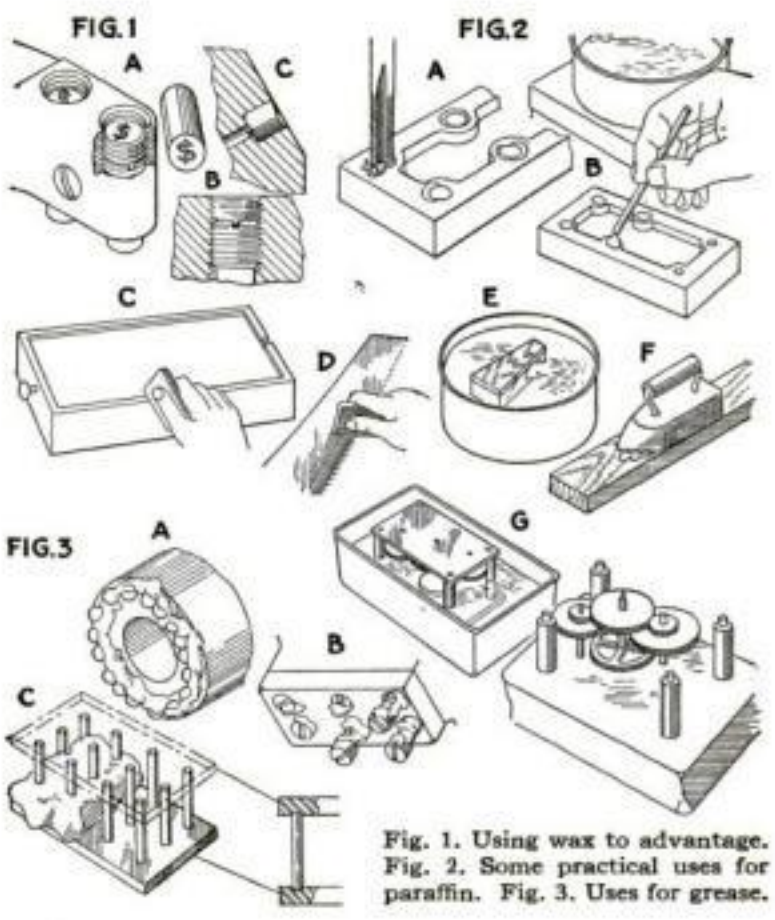

Fig. 1. Using wax to advantage. Fig. 2. Some practical uses for paraffin. Fig. 3. Uses for grease.

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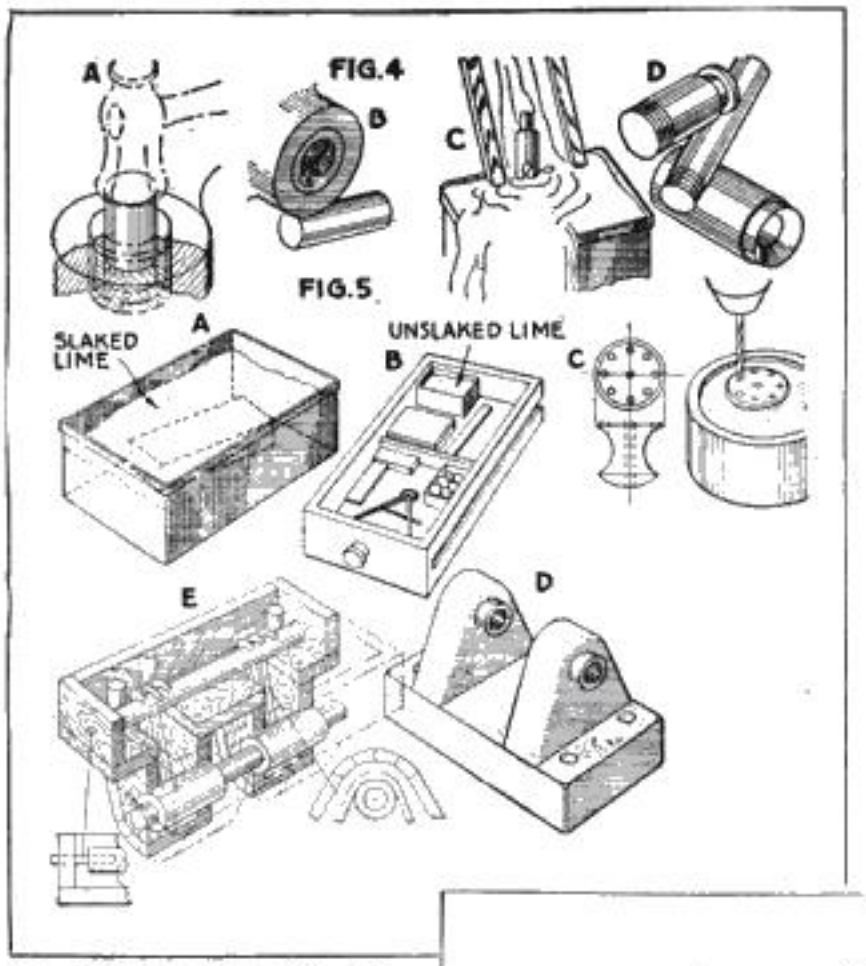


Fig. 4. Odd uses for oil in the shop. Fig. 5. Using cement, lime and gypsum to advantage.

cated at *B*, have a far wider range of action than a spring of the same strength and anything like the diameter. A live rubber tube or plug may be used in a pinch instead of a compression spring, as at *C*. As suggested at *D*, a typewriter eraser may serve as a ready-made friction wheel for an experimental drive. A big brother to it and one able to do real work is made from a piece of leather belting, placed between two disks and turned, as at *E*. Squares of the same material, cut as at *F*, make excellent vise pads. And used as at *G*, squares of leather are superior to wood as shimming and for shock absorbing material under machine based pedestals.

In places where it does not get damp, composition board makes an even better pad under some machines, as suggested at *A*, Fig. 7. Painted black, a tough grade of the same material makes an excellent, light-weight blackboard as at *C*, which is handy around the shop and superior to paper and pencil for laying out shop sketches. Painted any color and shellacked, it makes a durable splash screen as at *B* for messy wet operated machines. In this capacity it is superior to sheet metal, because it is cheaper, lighter and handier, and you can't cut or otherwise hurt yourself on it.

Red, black and gray fibers of various types already have some standard shop uses, although they should be employed more than they are. Though it has not quite the friction of leather or paper, sheet fiber is the most convenient of all materials for friction wheels because it requires no metal flanges. Fig. 8. *A* suggests the approximate proportions for such a self-supporting wheel with a force-fitted steel sleeve. For oily drives, sheet fiber makes an excellent and well-wearing V-pulley that is superior to metal because it gives a bulldog grip on the belt. As the torque is here much greater, a hub of larger diameter must be used, something like the one at *B*. A good use for fiber tubing is shown at *C*, where a short length driven into either end of a screw machine stock tube will make it noiseless.

A second article on "Odd Shop Uses for Common Materials" is scheduled for early publication.

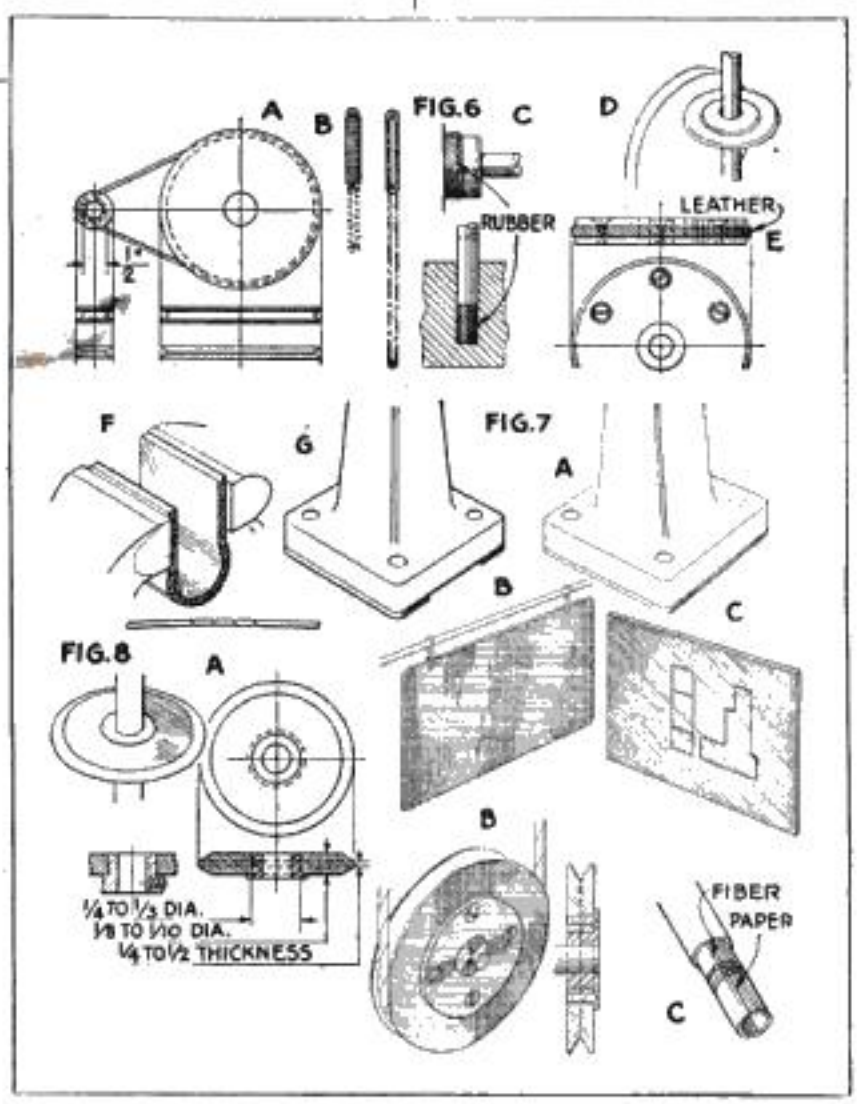


Fig. 6. Rubber and leather also have their place in the average shop. Fig. 7 and 8. Uses for composition board and sheet fiber.

Kink for Grinding Copper

GRINDING copper, as most machinists know, is one of the jobs that cause much consternation and worry about the shop. It can be done, however, with little preparation, trouble, or expense by the application of a simple shop kink.

Because of its quality of softness, copper when ground on an emery wheel tends to clog the pores of the abrasive and thus impede the cutting efficiency of the emery. This can be overcome by keeping the wheel surface covered with a layer of tallow, ordinary lard, or even butter, which will prevent the clogging of the emery pores and will not detract from the general usefulness of the wheel in the grinding of any of the other metals.—H. W. SWOPE.

Casehardening to Protect Bolts

FOR some time we had difficulty in finding bolts for the adjustment of the lift valves on a Diesel engine that would stand up under the continual hammer to which such pieces are subjected.

After trying every stock and factory bolt available, we decided to use ordinary wrought iron bolts, casehardened at the end subjected to the impact.

The bolts were put end down in a ladle containing cyanide of potassium. This was heated over a forge until the ends became red hot, after first shielding the ladle with sheet iron in order to carry off the fumes. By heating the bolts in this way a graduated heat was obtained, decreasing toward the other end, thus giving the bolts a good grain. After heating, the bolts were dropped in cold water to quench them. Bolts treated in this way have lasted two and three years while heretofore when stock bolts were used it was necessary to replace them every two or three months.—G. S.

Old Bill *Says*—

IF IT is necessary to build up a portion of a forming die with a welding torch, use chips of the same steel for the filling material.

You can make an emergency follow rest by clamping a straight-tailed dog to the tool post. A brass block is used under the dog screw to run on the work.

When doing accurate work, do not depend on the stated sizes of your die stock.

Every job or piece of work you undertake is a personal advertisement, and it is up to you as to whether it is a good or a bad one.

When locating a hole or button on the milling machine with an indicator, an offset boring head can be used to good advantage for holding the indicator.

If you have any grouches, leave them at home; no one else is interested in them.

A periodic inspection of the line shaft and the bearings will eliminate a lot of extra pull on the motor.

Rigging the *Bluenose* Model

The finished model rides imitation waves just as its prototype sails the seas. (See page 39.)

By
E. ARMITAGE MCCANN
Master Mariner

LIKE all fore-and-afters, the *Bluenose* gets much of its beauty from its rigging and sails. Everyone enjoys the magnificent sight of a sailing schooner with its sails up and bellied in the wind. Sails always give a sense of action and a note of life, and because of this much of the success of the model depends on the care with which the sails are cut and rigged. A fore-and-after has about the simplest rigging of any ship, so no difficulties should be encountered on this score.

Having completed the hull and placed all of the deck fittings properly, we have next to study the sail plan and rigging and then set about making and placing the two masts. The original masts on the *Bluenose* were made of spruce, so dowel rods left in their natural color will serve nicely.

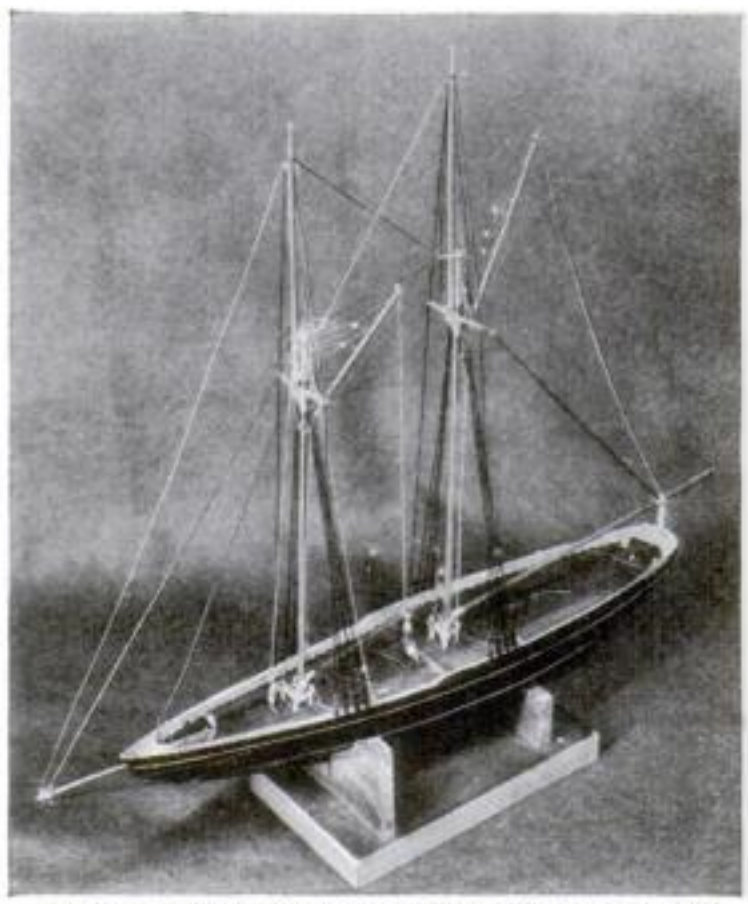
The bow-sprit—to begin forward—has a square heel which fits into the hole in the sampson post and at the outer end has two eye bands, the inner one with four eyes and the outer with two, one above and one below (see page 96). These are of No. 26 tinned wire. Twist the two or four eyes in it with just half a turn, file a slight notch in the spar, put the wire round it, twist the ends together, cut them off fairly close, squeeze them into the wood with pliers, and then give each eye an extra twist. The eyes should be as small as it is possible to make them. The inboard part of the spar and the bands are white; the rest is varnished.

Both lowermasts are the same, but of different length and thickness. The doubling, where the two masts are parallel, is cut square. Glue and nail the trestletree on either side, and below them fasten the cheeks. Across the fore side, resting on them, fasten the wooden crosstrees. Now cut a strip of thin copper or brass and bend it to shape. Nail this in position to the after block and the crosstrees. Across the crosstrees on either side lay a small quarter-round piece to prevent the rigging from chafing. The crosstrees will have two lifts on either side. These can be of thin cord or wire, hitched to the side eyes of the top bands, passed through holes in the crosstrees, and tied underneath.

At the top of the mast file a slightly smaller square on which the cap fits. Between the cap and crosstrees on each mast put three eye bands. These are similar to those on the bowsprit, except that the upper two have eyes on both sides and abaft, and the third, eyes abaft only.

The caps can be made from celluloid or metal. They fit on the lowermasts and have a hole on the fore side for the topmasts to pass through. The distance between the holes is the same as the thickness of the crosstree, so that the mast will stand parallel. The irons for the stays can be twisted from No. 22 wire and soldered at each twist and at the two ends. The upper ones are bolted with a pin right through the caps and masts and the lower one (forward) through the mast.

At the lower end of the mast, ½ in. from the deck, there is a ring for the boom jaws to rest on; this can be celluloid and should have elbows under it for support. Below this there is a quarter-round ring, representing the mast wedges and mast coat; this lies close on the deck. Before



The completed rigging as set up temporarily before the sails are cut and fixed. Compare with plan on page 94.

WORKACE Electric WOODWORKER

A complete electric workshop *for home or business*

EVERY man who has a workbench has often wished for a complete outfit of power driven woodworking machinery. Such a workshop is now as easy to possess as a radio set, and costs much less.

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The price of this complete outfit is only $89.00. This is possible because of the up-to-date manufacturing facilities of the J. D. Wallace Company. With the easy payments plan, the outfit will pay for itself as you use it.

With this electric workshop you will have time to turn out some beautiful and useful Christmas presents. And speaking about Christmas—What a present for the boys!

The Workace Electric Woodworker produces clean, accurate, workman-like jobs. Amateur or expert can do excellent work.

includes all this:

- 4" Planer
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Endless V-Belt, two 4' and one 2¼' V-Belt, Pulleys, Cast Iron Sub Base and 10 ft. Cable with separable Plug.

The Planer and Circular Saws are each complete units and may be purchased separately at the correspondingly low price of $25.00 each.

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putting these lower fittings on or stepping the mast, the mast hoops should be put on, otherwise they will have to be split.

The mast hoops are rings a bit larger than the masts. Rings for rod-leads, which can be bought for a trifle at fishing tackle shops, will serve for these and the topmast hoops, or they can be made by twisting wire around a stick of suitable size, cutting it, and bringing the ends together. These should be painted white before putting them on the masts.

The masts are white from the deck to the jaw supports and from the cheeks to crosstrees; the rest is varnished.

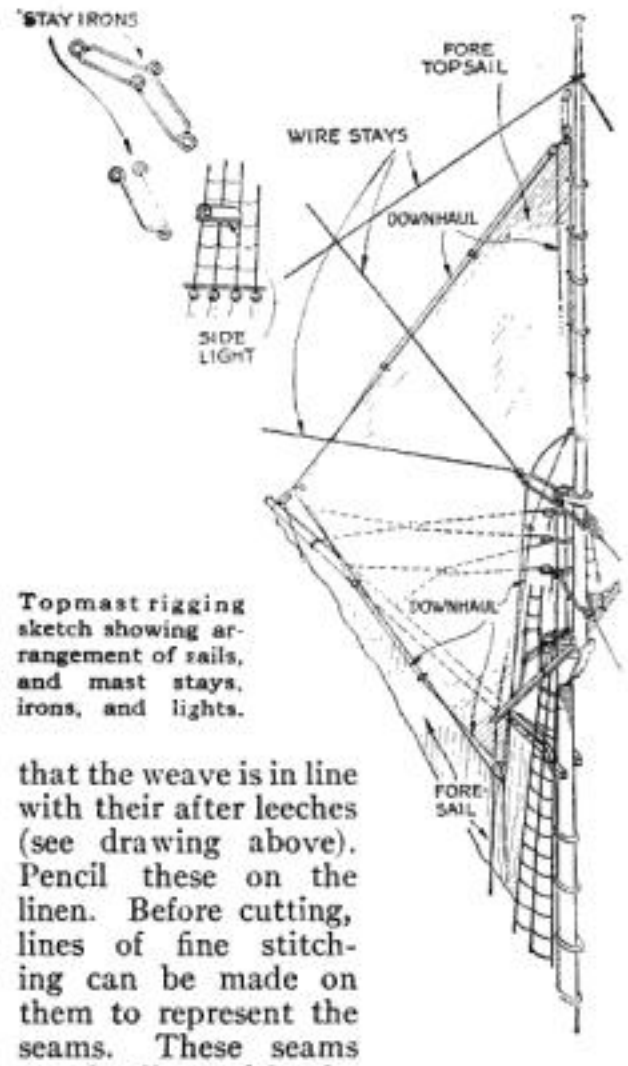
The topmasts have a square cut in their lower ends to fit between the trestletrees. When in position, a piece of metal is nailed to the trestletrees across the front.

The staysail boom has an eye at the fore end, a hole through each end for the lacing, and a traveler at the after end. This traveler, as for the fore and main booms, can be made by bending a strip of metal to shape and soldering a loop of wire passed through the lugs on either side. These must be made to fit tightly on the booms.

The fore and main booms have jaws at the fore ends. These are best made from boxwood cut to shape, and glued and riveted to the boom, which has been flattened slightly to receive them. They have small eyebolts close to the mast for the lacing.

Just inside the traveler at the main, there should be a cleat to which the topping lift is lashed; and from the traveler to the end on both sides there should be a foot rope.

The gaffs have jaws, as with the booms; and between them, fastened to the end of the spars, is a double wedge-shaped piece of wood. Note that as these gaffs are set at a sharp angle with the mast, the jaws and traveler must be cut to let the spar sit close to the mast. The fore gaff has five eye bands and the main seven, at the positions shown in the plan below.



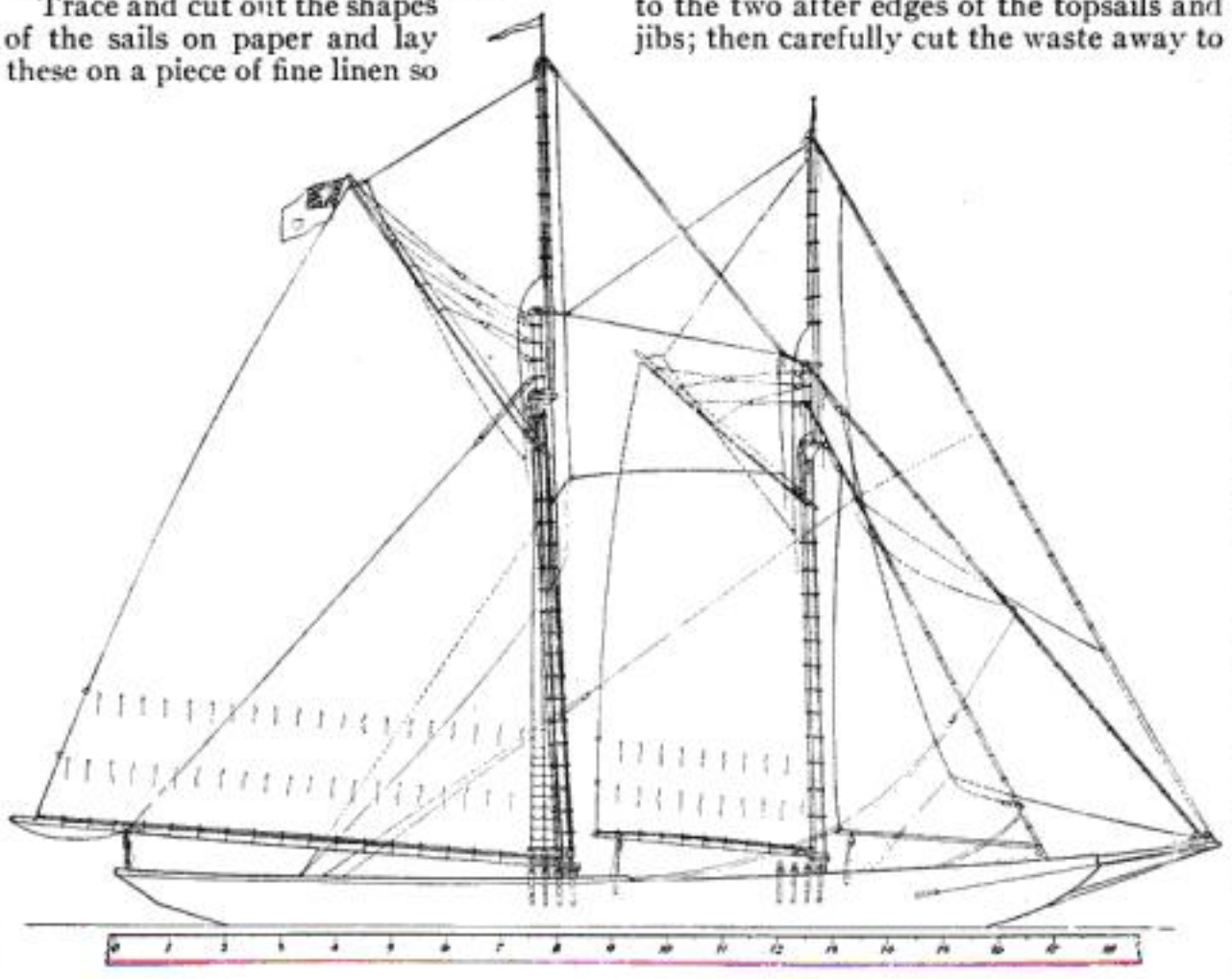
Topmast rigging sketch showing arrangement of sails, and mast stays, irons, and lights.

Trace and cut out the shapes of the sails on paper and lay these on a piece of fine linen so that the weave is in line with their after leeches (see drawing above). Pencil these on the linen. Before cutting, lines of fine stitching can be made on them to represent the seams. These seams are in line with the after leeches of all sails except the two jibs, where they follow the after leeches and feet and meet in a line at right angles to the head or forward edge. To make sure that they are straight, these lines should be ruled in lightly with a pencil.

Cut the sails out roughly and turn them in at the pencil lines with a hot iron, allowing a little stretch, which should be from a bare ⅛ in. for the smaller sails to a full ¼ in. for the mainsail.

If the sails are to be limp, they will need a fine hem all around.

If they are to be wind-filled, stitch some No. 26 tinned wire to the after leeches of the fore and mainsails and staysail and to the two after edges of the topsails and jibs; then carefully cut the waste away to



The entire sail plan, showing the location and scaled size of each sail. A history of the *Bluenose* can be obtained by sending a stamped envelope and a request for Home Workshop Bulletin No. 2.

about ⅛ in. of the turned-in edges.

To belly them out I took a piece of soft wood and cut rather more than the desired curve on it. Starting with the largest sail, I put a piece of tissue paper over the wood and pinned the sail down to this and stretched it to the desired size, with the hem underneath. I then gave it one full coat of white brushing lacquer. When thoroughly dry I took it off and cut the wood for the next, and so on. If the sails wrinkle a bit at the corners, so much the better. Any paper that sticks to them can be sandpapered off. This gives them a reverse curve, but they readily reverse again.

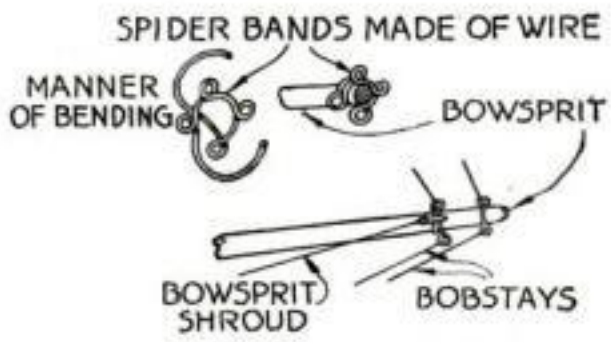
The mainsail has two rows of reef points at every seam. These can be No. 24 sewing cotton, and should be knotted on either side of the sail. See the plan on page 94.

Seventeen mast hoops should be stitched to the forward edge with fine cotton. The mast should then be rove through these, the boom put in position, and the sail laced to it with a jambing hitch. Do likewise with the gaff.

It will be well to have the gaff blocks attached before attempting the lacing.

There is a sheet block at the end for the topsails and blocks seized into bridles as shown for the peak halyards. These bridles are of varying length so that the blocks will be in line when the halyard is rove. There are other blocks seized to the eyes under the jaws, for the topsail sheets to lead through. These should all be ⅛-in. blocks. A 3/16-in. double block is fastened to an eye above the jaw for the throat halyard. The foresail rig is just like the main rigging.

You will need nearly 100 very small rings for staysail hanks and downhaul leads. These can be made by twisting fine spring wire around a darning needle, cutting them apart, and flattening with a hammer. Another and easier way is to cut up a piece of chain, cutting every other link and rounding those left. The chain should have about 18 links to the inch to give the desired 1/16-in. rings.



Method of making the two spider bands for the tip of the bowsprit by bending thin wire.

Next month we shall complete the rigging of the model and construct a base for it.

For those who wish more complete details as to the construction, a set of full scale blueprints has been prepared and can be obtained by sending seventy - five cents and a request for Blueprints Nos. 110, 111, and 112. (See the blueprint list on page 99.)

Next—Stagecoach Models

AGAIN a pioneer in the field of model making, POPULAR SCIENCE MONTHLY offers next month the first practical article ever published on the construction of miniature stagecoaches.

Model makers who have built ships and trains will find an entirely new and wonderfully fascinating pastime in reproducing in miniature the colorful, picturesque old coaches that made history on the western frontier. The first in the series is a model of the *Diamond Tally-Ho*, which ran between San Diego and Julian, Calif., in gold-mining days.

Getting the Most Out of Your Axe

MANY of us exercise meticulous care in the sharpening of our shop tools but forget about the axe that we use to chop our kindling. An axe, like all other cutting tools, will do its allotted job quicker, with more accuracy, and with less physical exertion on the part of the user if its edge is in perfect condition.

Grinding should be attempted only to get the blade in shape, and once it is as desired the keenness of the edge should depend wholly on the use of a file and whetstone. The use of a grindstone tends to destroy the temper of the steel even under the most ideal conditions, and therefore should be resorted to only if the blade has lost its shape.

To obtain the correct edge, plan your grinding so as to obtain a fanlike shape making a gradual taper up to the cutting edge. This taper is most important, as it throws the chip out and thus keeps the notch in the wood free and clean. Use plenty of water on the grindstone, which is to be preferred to an emery wheel or a dry stone.

After the shape has been obtained, the blade is ready for the actual sharpening operation, which is accomplished with a file. Keep the blade down to the required thinness by filing towards the head of the axe, cutting only on the forward stroke. The sides of the blade should be rolled over to meet the cutting edge, but this is not done until the flat of the blade has been filed to the desired thinness.

If the filing is done in a shop, the blade can be held in a vise; if done outdoors, the head can be placed in a notch cut to the proper size in a tree stump. If the axe is of the double-edged type it can be driven into a log and thus held while the free edge is filed.

THE operation of honing the axe is one that very few people realize is important, and is the one thing that should be done frequently.

A hard, fine stone is the best for honing. It should be rubbed over the entire edge with a rotary motion. Be careful, however, not to tilt the stone at too great an angle. Both sides should be honed thoroughly; in this way the burr formed by honing one side is removed when the other side is honed.

Treat your axe as you would any other tool and you will be surprised how quickly the next pile of kindling will be chopped up.—G. H. VAN WALTHER.

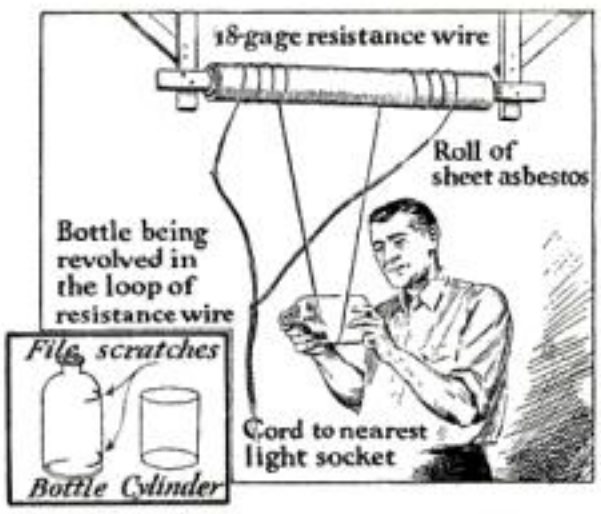
Electrically Heated Wire Cuts Glass

FOR cutting cylindrical glass, as when removing the tops and bottoms of glass bottles or dividing glass tubing, the method to be described will be found efficient and successful.

Build a wooden frame as shown and hang it overhead in such a position that it will be near an electric light socket.

Wrap three or four thicknesses of sheet asbestos around the crossbar of the frame and then wind 10 ft. of 18-gage resistance wire around this. Bring the center down in a loop or V, making it low enough to be handy to work with (see illustration).

Attach a drop cord long enough to reach the light socket, attach a plug to one end, and bring the other end down to the crossbar. Separate the two wires in



The bottle is placed in the loop of wire at one of the file marks and is then revolved slowly.

the drop cord, bare two or three inches of the end of each, and attach one to each end of the resistance wire, as shown. The apparatus is now ready for use.

To cut a piece of cylindrical glass, scratch a short straight line with a corner of a sharp file at the point and in the direction you want the glass to crack. Place the bottle or glass tube in the loop formed by the resistance wire in such a way that the bottom of the loop fits in the scratch or cut. Turn on the current, thus causing the resistance wire to become red-hot. Slowly and carefully revolve the bottle in the loop, always keeping the same line, and the glass will part with a clear, straight cut.

The sharp edges can be removed with a file or stone.—DICK HUTCHINSON.

Making Writing Appear on Whites of Boiled Eggs

AN EASY and effective trick is to letter a prophecy on the shell of an egg, using a mixture of an ounce of alum in a half pint of vinegar as the medium and applying it with a fine brush. Place the egg in water and boil for about fifteen minutes. The lettering on the shell will disappear, but on removing the shell, the prophecy will be seen on the hard-boiled white of the egg.

By serving hard-boiled eggs thus prepared, you can cause much curiosity and excitement among your friends, especially if some startling prophecy is used.

Turning Bowls and Bud Vases

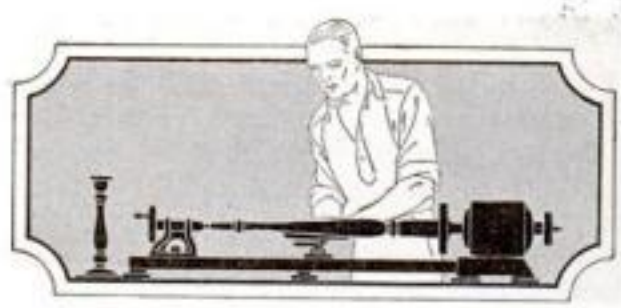
THE bud vase and nut bowl illustrated, aside from being attractive ornaments in any home, have the added value of being good object lessons in the art of using wood-turning tools for the owner of a motorized home workshop. They also make ideal projects for the school woodworking shop, especially in the use of the faceplate. Aside from their educational value they prove to be attractive and useful.

Bud vases made in matched pairs form splendid ornaments.

The designs were submitted by Paul N. Wenger, Manual Arts Supervisor of Greenwich, Conn., in a shop problem competition for teachers conducted by the Educational Department of POPULAR SCIENCE MONTHLY. His drawings and detailed instructions that accompanied them were awarded third prize in the advanced woodworking division of the competition.

Both the vase and the bowl are attractively embellished with inlays. By slight modification of the designs the projects as a whole can be made easier, if desired.

The originals were turned from Oregon myrtle, but any beautifully grained wood may be used. Since the amount of wood required is very small, it is advisable to use high-grade pieces, especially if they are to be presented as gifts.

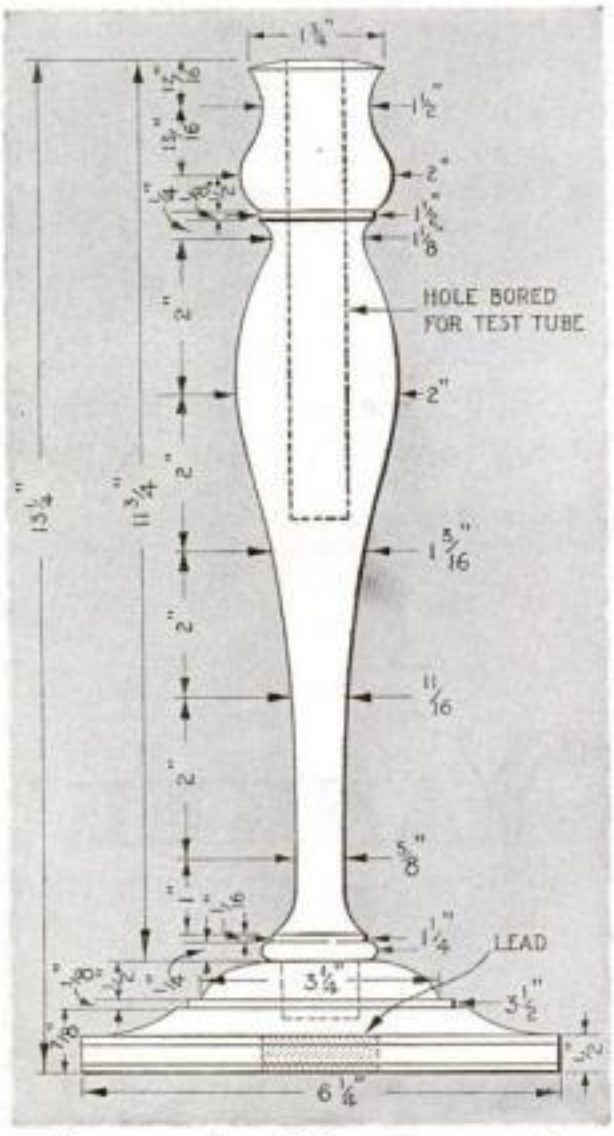


The design on the bottom of the nut bowl is applied with a decalcomania transfer. Many different designs can be bought at any of the large paint stores, supply stores, or manual training supply companies.

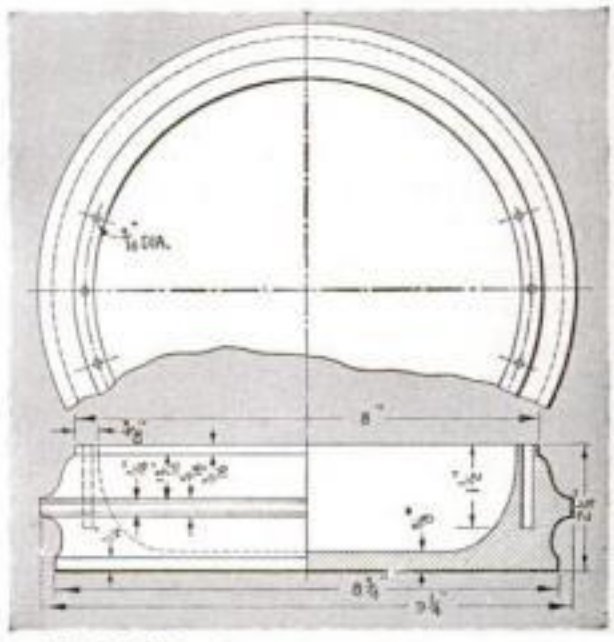
The inlay is set in a groove and is glued in place. The ends of the strip should be tapered so that they will overlap for about ¼ in. A clamp is placed over the seam and the glue allowed to dry for at least twenty-four hours. The whole then can be sandpapered and finished as desired.

An inlay adds to the attractiveness of this nut bowl, made by faceplate operations. A decalcomania is applied in the center.

As shown in the drawings, the base of the bud vase is provided with a lead weight. The hole may be cut square with a mortising machine if available, or it may be turned on the screw chuck. Fill the hole with lead shot and pour hot paraffin over the top, scraping off any excess wax flush with the bottom.



The vase can be made from Oregon myrtle or any wood having an attractive grain.



The inlaid bowl can be made from a solid piece or from a block made of sections.

Blueprints for Your Home Workshop

TO ASSIST you in your home workshop, POPULAR SCIENCE MONTHLY offers large blueprints containing working drawings of a number of well-tested projects. Each subject can be obtained for 25 cents with the exception of certain designs that require two or three sheets of blueprints and are accordingly 50 or 75 cents as noted below. The blueprints are each 15 by 22 in.

Popular Science Monthly,
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Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....
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86. 35-in. Twin Pusher
87. 30-in. Seaplane
89-90. *Bremen* (3-ft. flying), 50c
102. Morris Seaplane (record flight 12½ min.)
104. Tractor (record flight 6,024 ft.)

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21. Colonial Desk
24. Gateleg Table
31. Two Sewing Cabinets
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37. Simple Bookcase
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39. Chest of Drawers
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60. Welsh Dresser
68. Magazine-Rack Table and Book-Trough Table
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91. Modern Folding Screens
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56. Birds and Animals
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30. Tool Cabinet, Boring Gage, and Bench Hook
65. Six Simple Block Puzzles

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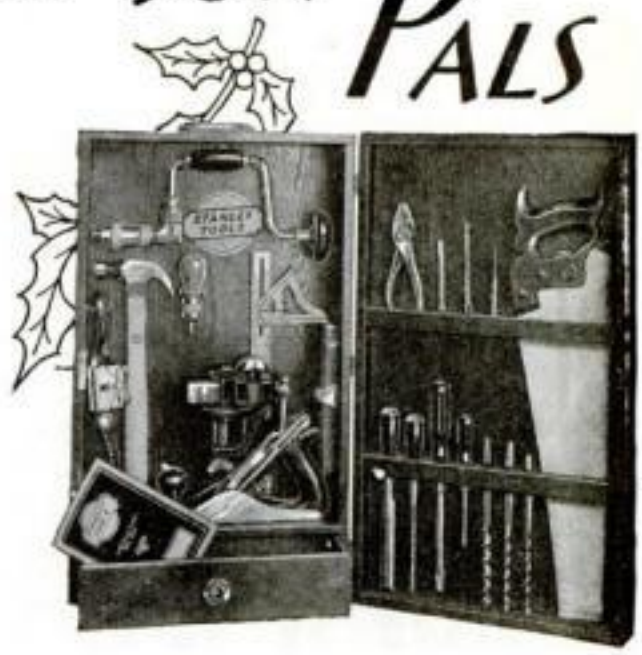
FATHER and SON PALS



EVERY father wants to be his son's "pal". But how? The hustle and hurry of business, the few leisure hours, the lack of common interest—all conspire to prevent real comradeship.

There is one place where thousands of fathers and sons are playing today like real pals .... the home work shop.

It may be in the basement or in the attic. Somewhere, you will find a small space cleared away for a work shop. It requires only a few tools to start. A Stanley Tool Chest usually forms the nucleus around which to build.

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There are ten different Stanley Chests from which to select, all full of honest-to-goodness tools. Ask your hardware dealer to show them to you. Also the Stanley Plans which show how to make 25 useful articles. They cost only 10 cents each. Ask him for Stanley Tool Chest Catalog No. S35e or send to us for a copy.

THE STANLEY RULE AND LEVEL PLANT
New Britain, Conn.

STANLEY TOOLS

STANLEY TOOL CHESTS

Book Ends Made of Leather

By F. CLARKE HUGHES

Bill folds, book ends, key cases, and many other useful articles can be made by this new method of embossing.

BOOK ends as shown are both decorative and durable and when completed will make a gift that is practical for any occasion or will be a valuable addition to the reader's own reading table. They are made by a new and easy method of embossing.

First, decide on the size and shape desired. The size should be one to suit the average book. Perhaps the best procedure is to fold and cut a number of paper patterns. If one keeps the general proportions in mind and allows these trial patterns to change only for variety in shape and general design, various attractive forms can be developed. Or, if the reader prefers to use the exact design shown, he may make his first pattern like the drawing. The patterns should be cut from heavy paper or cardboard. It should be noticed that No. 3 is ⅛ in. smaller all around than the other two patterns.

Two pieces of heavy sheet metal will be needed for pattern No. 3. These may be either sheet steel or common sheet iron about 1/32 in. thick. After the pattern is traced on to the two pieces of metal, cut them to shape with a pair of tinner's snips. The folding can be done in an ordinary vise.

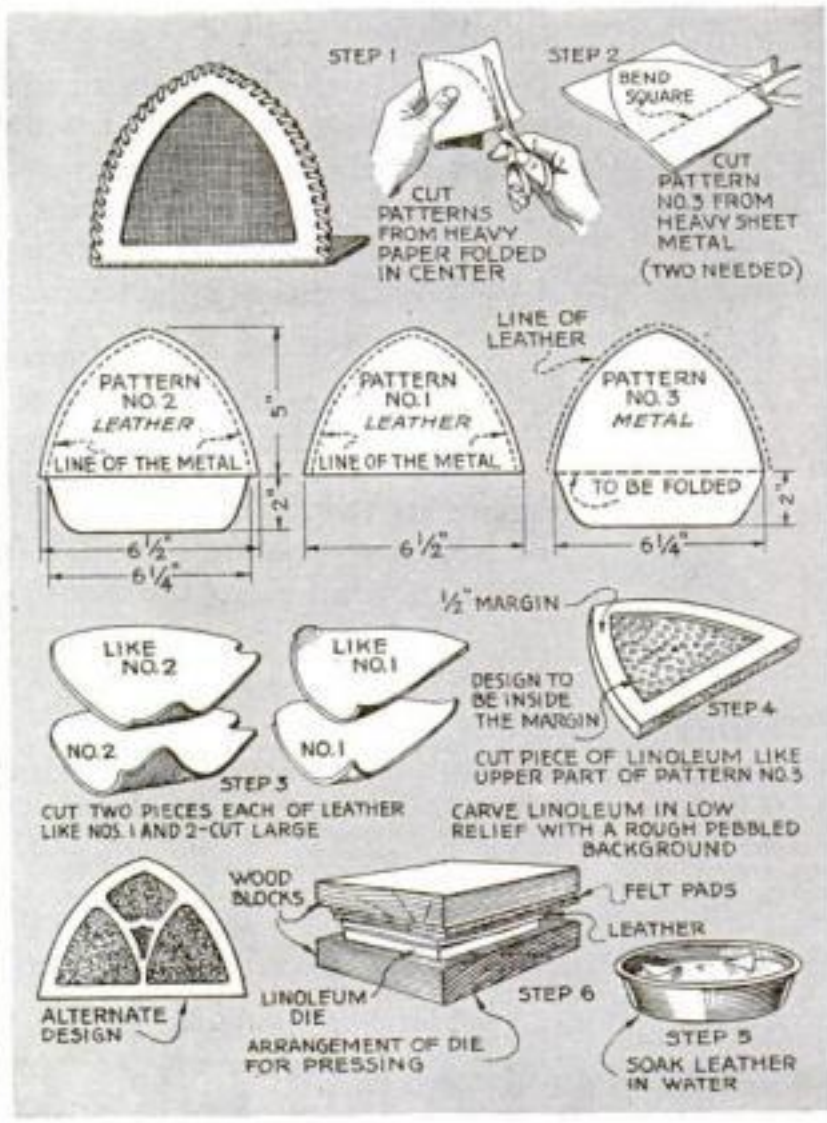
The leather for pattern No. 2 should be a good grade of "tooling calf," which is the trade name for a leather especially tanned to meet the needs of shaping or embossing. If this leather cannot be procured, a grade of smooth leather of an average weight and quality may be used. The leather for No. 1 may be cheaper and thinner than that for No. 2 because it is for the side next to the books. All of this material can be obtained at any leather or harness shop or in some cases at shoe repairing shops.

The die for embossing the design is cut from battleship linoleum and should match the upper part of No. 3 pattern in both size and shape, as shown in the sketch marked "Step 4." The design within the space to be carved may be either solid in area or broken up as in the alternative design. The carving of the design, which should be in very low relief, can be done with a pocketknife or with regulation carving tools, if handy. The carved part should be gouged out in irregular pieces to give a rough pebbled surface to the background. This rough background in turn gives a pebbled surface to the damp leather.

When the die is carved and ready, a trial impression should be made with wet paper. Then the No. 2 pieces of leather should be dampened by placing them in a bowl of water for a few seconds, and each of them in turn should be placed face downward on the die. Be careful to have the same projecting space all around. Over the leather should be placed several thicknesses of felt or other soft material to serve as a pad; next, these should be placed between two wooden blocks as shown in Step 6.

Either a letterpress or an ordinary vise may be used to supply a heavy pressure to the blocks. After the embossing, the two pieces should be allowed to dry thoroughly.

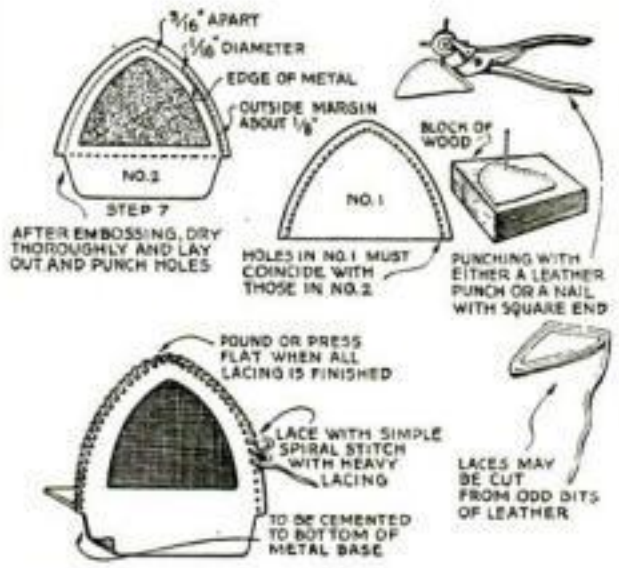
The holes should be punched as shown in Step 7. Care should be taken as to the distance between holes and their size. If a regular leather punch is not to be



Patterns are cut from heavy paper, the leather is cut to match, and the front piece is soaked in water and embossed with the die.

had, an ordinary nail may be used as shown. The line of the punching should follow closely the edge of the metal so that when the two parts of each end are laced over the metal, they will be stretched tight. Holes are punched only in the leather.

For this type of leather work, a heavy lacing looks best and in the case of the book ends these laces may be cut spirally



The edges are laced over with the ordinary type of plain spiral lacing, cut from bits of leather.

from the odd scraps left from the shaping of Nos. 1 and 2. The width should be about ⅛ in., and a plain stitch used as indicated.

The 2-in. piece at the bottom of pattern No. 2 should be glued or cemented to the base of the metal and forms a cushion that prevents the metal from marring the surface on which the book ends may be placed. Shellac is suggested as a cement in this case because it adheres well to metal.

For a finish either the original color of the leather may be preserved and polished with ordinary shoe dressing or wax, or the different parts of the design may be colored or toned by applying ordinary oil colors mixed to a thin consistency with gasoline and wiped off with a soft cloth before they dry. The strength of the tone depends largely on the amount wiped off. Any surplus may be removed with gasoline. These colors should then be waxed and polished.

This is the third of a series of articles by Mr. Hughes dealing with this new, easy, and efficient method of embossing leather. An article describing the making of an attractive letter opener with leather for the decoration is scheduled for early publication.

Preventing Christmas Tree Bulbs from Burning Out

EXCESSIVE line voltage, which often burns out Christmas tree lights, can be reduced by the interposition of a resistance in the circuit. There are two ways of accomplishing this. One is to place a wire resistance in series with the bulb line. The other way is to attach another bulb socket to each set of lamps, making nine in series instead of eight.

This slight addition to the total resistance of the circuit will reduce the effect of any moderate amount of rise in line voltage.—K. A. CAIRD.

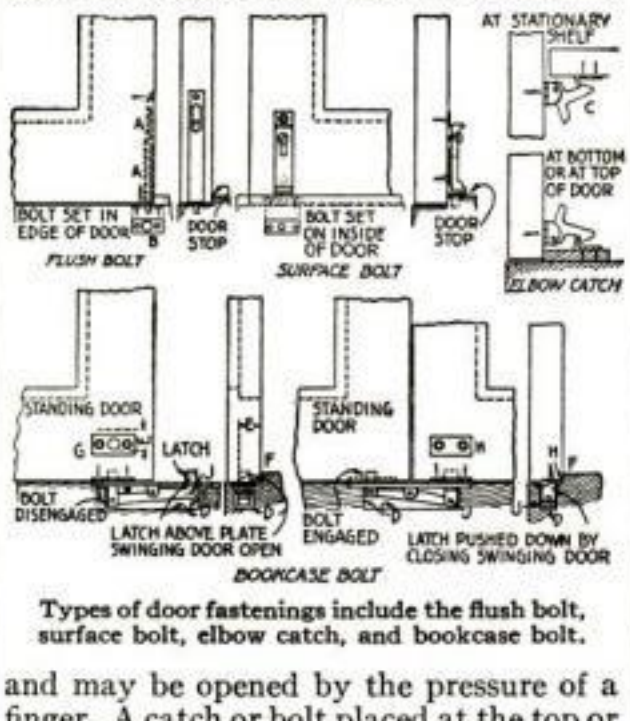
Hints on Attaching Door Fastenings

EVERY home worker is likely to be confronted at some time or other with the task of fitting a standing door fastening. There are many different fastenings on the market, but of the large variety, the ones here described are among the most common and most efficient.

A bolt may be placed in the edge of the standing door at either the top or bottom or both. The recess in the edge of the door to receive the bolt *A* must be cut and the face and plate fitted carefully to insure good joints with the wood.

The surface bolt is easier than the flush bolt to fit, for it may be fastened directly upon the surface of the door and a hole bored to receive the bolt, or a striker fitted, if desired.

The elbow catch is easily fitted; the door will catch and hold automatically



Types of door fastenings include the flush bolt, surface bolt, elbow catch, and bookcase bolt.

and may be opened by the pressure of a finger. A catch or bolt placed at the top or bottom is not so easily manipulated as a catch engaging a striker fastened to a middle shelf as at *C*, which obviously is not possible upon an adjustable shelf, but is very convenient if the shelves are stationary.

The bookcase bolt is more difficult to fit than either of the other types, but it is the most automatic of any of them. Fit the bolt and latch in the bottom of the door opening, the center of the rocker being under the joint between the doors. Cut out the recess *D* to receive the mechanism, drop the bolt into *D*, and fit the plate flush with the door opening. Fit striker plate *G* in the bottom edge of the standing door so it will engage the bolt accurately. When the door closes it will force the latch down and the bolt up into the striker of the standing door. Fit the striker plate *H* of the latch into the bottom edge of the swinging door, flush with the inside as indicated. By driving out the pin *J* of the latch, reversing the latch bevel, and replacing the pin, another bolt may be placed at the top of the door opening, thus holding the top and bottom of the standing door firmly.

It is obvious that unlocking and opening the swinging door will allow the latches to spring out and the bolts of the standing door to draw back into the recess *D*.—D. W.

Saving Space with a Folding Bench

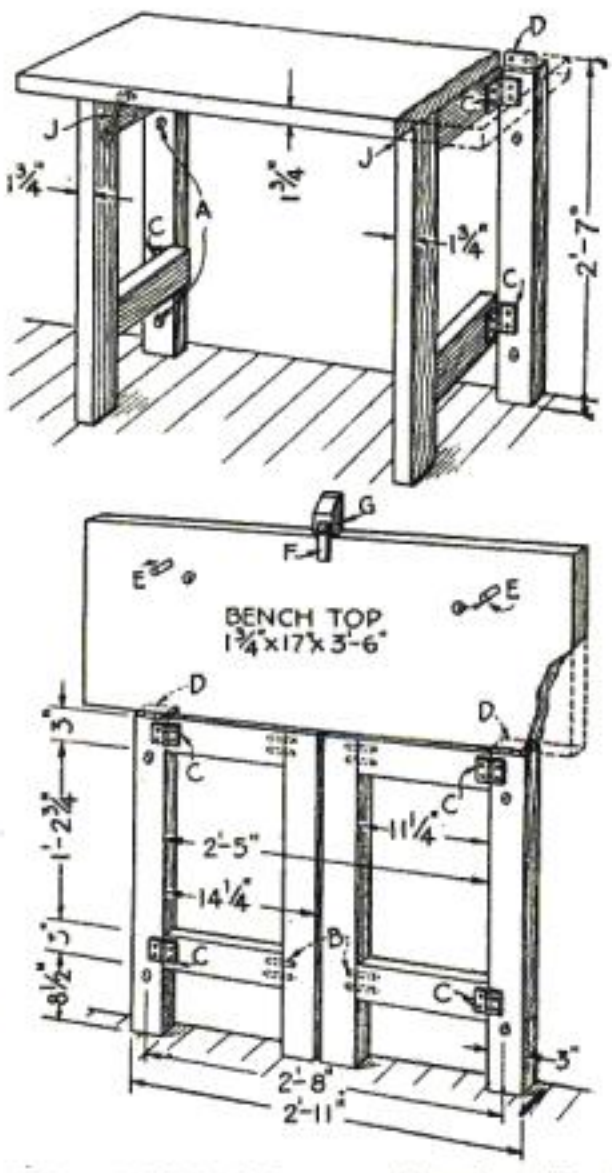
FOR those who enjoy working with tools but are cramped for room, this folding workbench should solve the problem. Opened, it provides ample space for large work; closed, it rests against the wall, out of the way and practically out of sight.

The four legs, 1¾ by 3 in. by 2 ft. 5¼ in., are made of hard wood. Fasten two of them to the wall 32 in. between centers with 3½-in. No. 14 screws at the top and bottom as at *A*, placing the screws so they will enter the wall studding. If there is a baseboard around the room, cut a piece from the back of each leg to allow them to be folded closely against the wall. Cut and fasten four rails 1¾ by 3 by 11¼ in. to the front legs with glued dowels as at *B*. Hang them to the back legs with strong 2½ by 2½ in. iron hinges with 1½-in. screws as at *C*.

Make the top 1¾ by 17 in. by 3 ft. 6 in. and hang with 2½-in. hinges as at *D*, using 2 or 3 in. screws in the end wood at the top of the legs. Open the front legs until they stand square with the wall, mark centers for ¾-in. dowels *E*, bore holes nearly through the top, and glue the dowels in place. Trim the dowels so they will enter the holes in the legs closely but not so tight that they stick.

When not in use the legs should be folded against the wall and the top lifted up and held there by a button *F* attached to a cleat *G*.

Place hooks and eyes at *J* to hold the top firmly against the legs when the bench is in use.—C. A. K.



The bench, folded, is flat up against the wall out of the way; open, it is rigid and surprisingly roomy.

Mending a Broken Garage Door

Wooden dowels ¾ in. in diameter were driven into the holes bored through stile and rail.

SWUNG open in a violent gust of wind, this garage door was badly damaged. The top rail broke away from the outer stile, two of the wood muntins between the panes of glass fell out, and the center rail pulled away from the hinge stile.

The garage builder, asked to supply another door, could not do so because one with six lights was required, whereas he was then using only doors with eight lights. The owner did not feel like buying a set of four new doors, and the broken door was therefore repaired.

The muntins were replaced and the top rail and the stile brought together. Two ¾-in. holes were bored from the edge through the width of the stile and extended 6 in. into the top rail. After the holes were cleared of chips, ¾-in. dowels were driven in and (the joint being tight) secured by nails from front and back.

Dowels were similarly driven through the hinge stile and into the center rail, but were not nailed until the joint had been wedged tight. To obtain the necessary pressure the door was closed, its mate being left open, and a 2 by 2 in. stick, 3 in. longer than the open space, was placed between the inside of the door frame and the stile of the damaged door. Heavy blows were struck on the high end, as illustrated, to force the rail back into place, and the nailing of the dowels held it there. The repair was completed in less than an hour.—ROGER. B. WHITMAN.

CONFIDENCE is needed in driving nails. Grasp the handle at or near the end. Start the nail with a good blow, not a timid one, and make the hammer swings short and snappy. They should be jolts; far-reaching swings are not necessary.

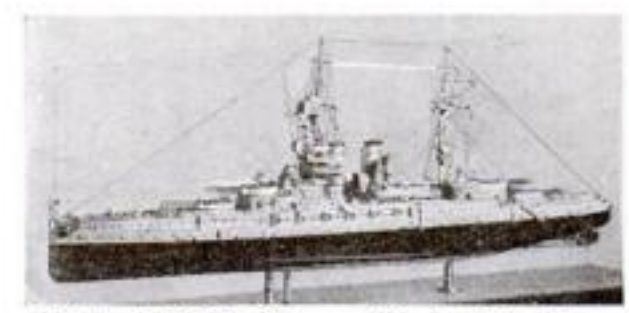
When the wind caught this door, it was badly broken. Accidents of this type are frequent.

How pressure was applied to close the joint between the hanging stile and the center rail.

Builds Marvelous Model of Famous Warship

TO MAKE this 40-in. long model of H.M.S. *Queen Elizabeth*, Gerald S. Rees, of Nelson, British Columbia, spent 700 hours of his spare time. Materials were obtained for the most part from five-and-ten-cent stores; the cost accordingly was negligible.

A perfect replica of Earl Beatty's flagship, the model is complete with large and small guns, binnacles, range indicators, chart rooms, searchlights, and rigging. The twin screws are driven by a small electric motor and the interior is electrically lighted.



Model of H.M.S. *Queen Elizabeth* built by Gerald S. Rees. The work took 700 hours' time.

The barbettes were fashioned from a plastic wood composition and molded from plaster of Paris, their shells being only 1/16 in. thick. Brushing lacquer, in battleship gray and red, was used for much of the finishing, because its quick-drying properties facilitated the work.

How to be *Generous* to a man at Christmas

JUST how does the Gillette Fifty Box qualify as the ideal Christmas gift for a man? Here's how—on these eight counts:

It is practical . . . Man, famous for his practical mind, insists on useful gifts.

Yet he probably wouldn't buy this for himself . . . From long habit, he is used to getting his blades in packs of five and ten. This will be a new and refreshing idea for him.

He'll be sure to use it . . . Blades are a daily necessity in every man's life. The Gillette Fifty Box is the most convenient way to have them.

It is personal . . . It's all to himself, for his own intimate, bathroom use.

It is good looking . . . Packed, as you see, in a metal box, velvet lined, with a spring-hinge cover. Blades are enclosed in brilliant Cellophane.

It is truly generous . . . With fifty smooth, double-edged Gillette Blades in easy grasp, a man can look forward to more continuous shaving comfort than he has probably ever enjoyed before in his life.

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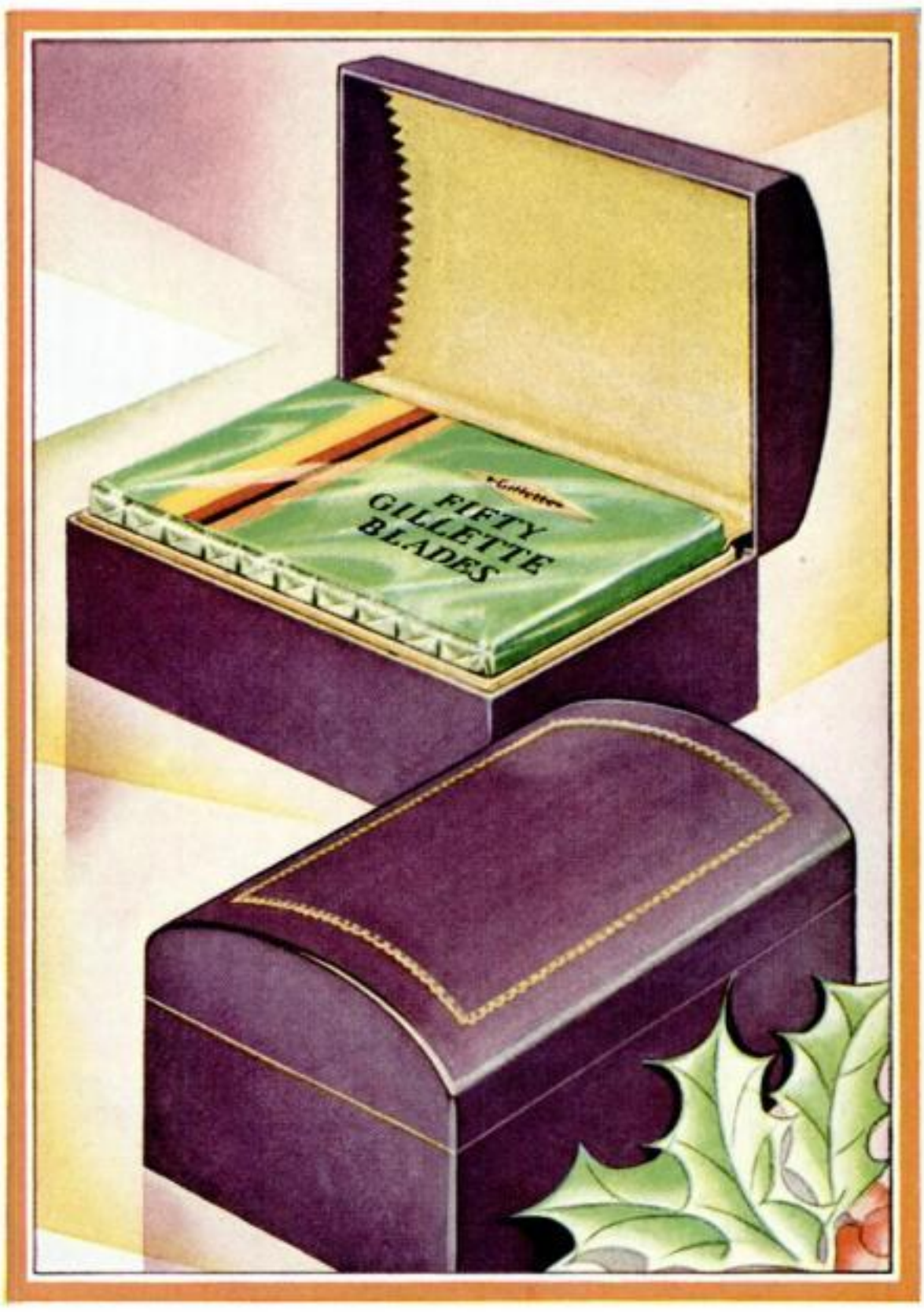

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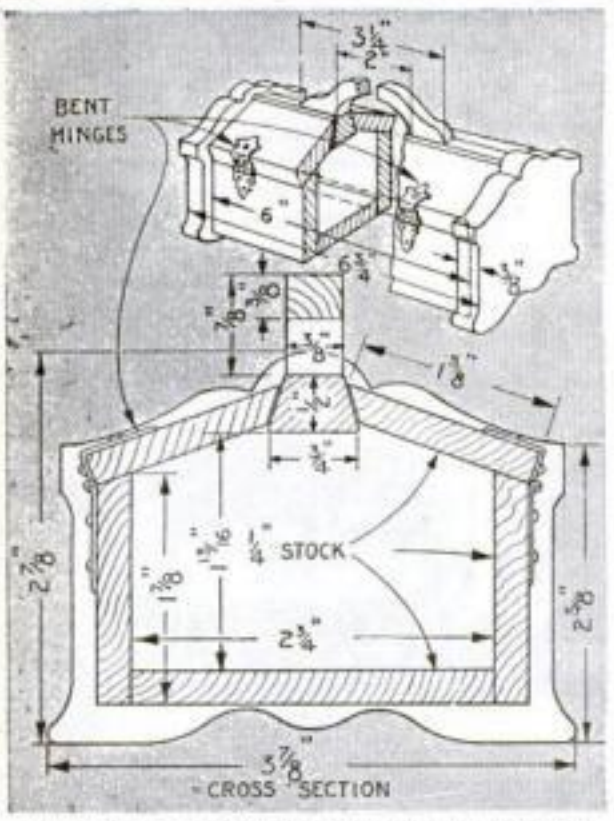
Useful Decorative Cigarette Chest

The chest in use not only serves as a container for cigarettes but can be used as a jewel box.

THE attractive chest illustrated holds about one hundred cigarettes. It also can be used as a jewel box if desired. Its construction is simple and the materials inexpensive, and with Christmas in the offing it presents a fine idea for a gift.

Gumwood was used by the writer but any available wood will serve. Small knobs can be added to the cover to facilitate opening the chest. After the chest is assembled, it should be sandpapered and lacquered.

The chest shown was finished in black lacquer with gold-bronze trim and lining. —DICK HUTCHINSON.



Dimensions and details needed in construction and a photograph of the finished chest.

Smoking—Reading Cabinet

LePage's Complete Plans and Instructions Show You How to Make it Yourself

LePage's Third Home Work Shop Book, only 10 cents, Shows How to Make These 20 Projects

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Rolled beside a comfortable chair this handsome, convenient cabinet brings your favorite books and magazines and favorite smoking things in easy reach for an evening of solid comfort. It even holds your book for you. The door of the smoking compartment when open becomes an adjustable book rest. And you can make it yourself—easily—by following the instructions in LePage's Job Plan No. 19.

Expert Instructions

You have expert instruction to guide you. The design, dimension drawing, photograph, step-by-step directions and the actual furniture itself was made by William W. Klenke, Instructor in Woodworking, Central Commercial and Manual Training High School, Newark, New Jersey. His experience as an expert gives assurance that this project and the directions for making it are thoroughly practical. To make the Cabinet as shown in the illustration, order LePage's Job Plan No. 19 at 10 cents. Look over the contents of LePage's book and the Job Plans available as shown in the column at the left. The price of the book is 10 cents. The Job Plans are 10 cents each and are for projects requiring more elaborate instructions than those shown in the Book. In all cases the instruction consists of printed step-by-step directions, dimension drawings or full-size patterns, and a photograph of the finished article.

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Please also send the following Job Plans..... (indicate by number those you want. See column at left), for each of which I enclose an additional 10 cents.

Mr. Palmer at the bench in his woodworking shop. Note the completeness and neat arrangement of the tools and the many jars containing hardware.

Home Workshops That Reflect Ingenuity of Readers

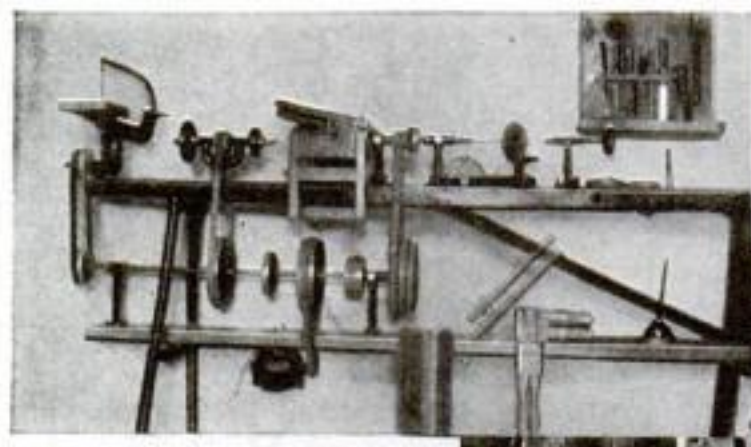
HOME workshops vary in many ways. Some are unique because of their low cost; some are outstanding for their completeness; each has some feature a little bit different from the others. That is to be expected, since some amateur craftsmen enjoy small work, others large work, and still others prefer unusual types of artistic metal or woodwork.

C. E. Palmer's shop, illustrated above, is typical of the more complete type of home workshop. The arrangement of his bench, tools, cabinets, and the neat use of jars for storing screws and other hardware are noteworthy. Neatness such as is exemplified by Mr. Palmer's shop is imperative if neat, accurate work is to be done.

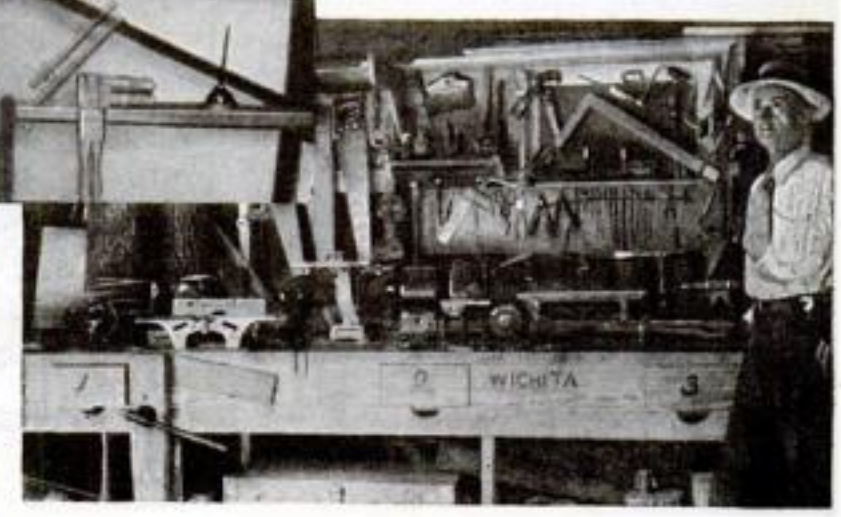
A long extension cord allows the free movement of the lamp to any portion of the bench. Mr. Palmer finds that storing lumber overhead keeps the floor of the shop clear and the general appearance orderly. Mr. Palmer is the advertising manager for a large manufacturing company in Chicago.

For a workshop of low cost, James A. Cooper, of Rochester, N. Y., probably holds the record. He has a jig saw, grinder, buffer, circular saw, lathe, and sanding drum, all motor driven, yet the whole group cost him only $22 to build. This price includes the small electric motor. The frame was made from bed posts and angle beams, while the ways were made from the frame of an old model-T Ford chassis. The machines themselves were built mainly from pipe fittings and have babbitted bearings. The spindles are 11/16-in. cold rolled steel shafting. Mr. Cooper uses these machines and finds them practical and efficient.

Many woodworkers enjoy using the rarer woods. Among them is W. S. Branaman, of Wichita, Kan., who cuts his own wood. At the left of the illustration can be seen a log of 34-year-old persimmon. Mr. Branaman directs most of his efforts to attractive inlay work, using as his medium many fine and rare woods. Among his recent pieces is a beautiful inlaid checkerboard. His shop contains a large variety of hand tools along with a motorized circular saw, lathe, and planer.



This set of woodworking machines was made by Mr. Cooper at the cost of twenty-two dollars, including the price of the motor.



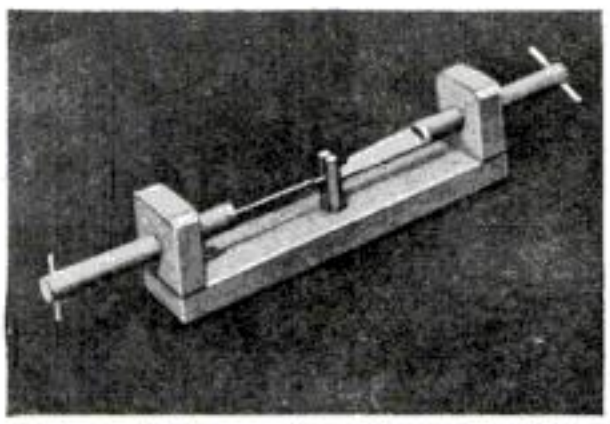
Each worker to his own liking. Mr. Branaman finds pleasure in cutting rare woods from the raw and using them in doing attractive and novel inlaid work.

If your shop has unusual features, send a photograph or photographs, accompanied by a brief description, to the Home Workshop Editor. Five dollars will be paid for each photograph found suitable for publication.

Model "Props" Bent from Thin Blanks

A TWISTER for forming model airplane propellers from thin balsa blanks can be made from a few pieces of scrap wood and a small length of broom handle. Twisting propellers with this device eliminates bothersome carving.

If the broom handle fits into the holes firmly, wing screws will not be necessary. If screws are used, however, drill small

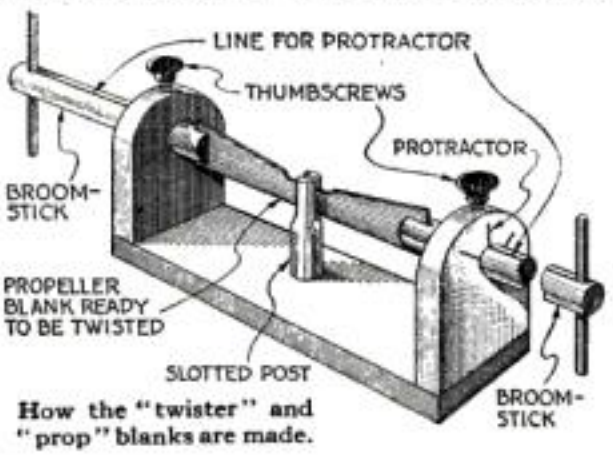


A steamed balsa wood model propeller blank held in an easily constructed twisting device.

holes and allow the threads to cut their way into the wood.

Make the balsa propeller blanks about 1/8 in. thick. Place a blank in the twister, steam it, and give it the desired amount of twist. Allow it to set and then obtain the wing curve by sandpapering.

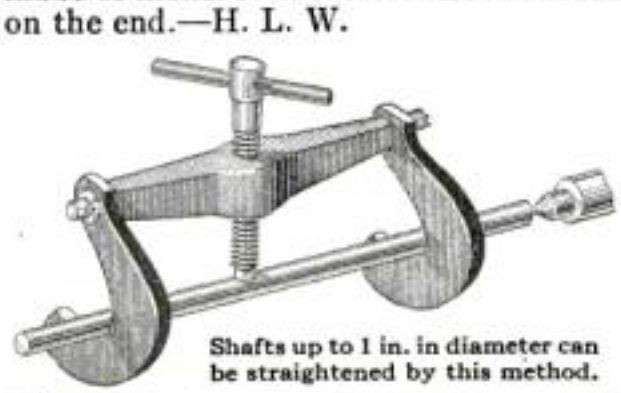
It is best to paint balsa props with banana oil so that any dampness will not affect their curve.—JAMES J. DOYLE, JR.



How the "twister" and "prop" blanks are made.

Straightener for Shafts

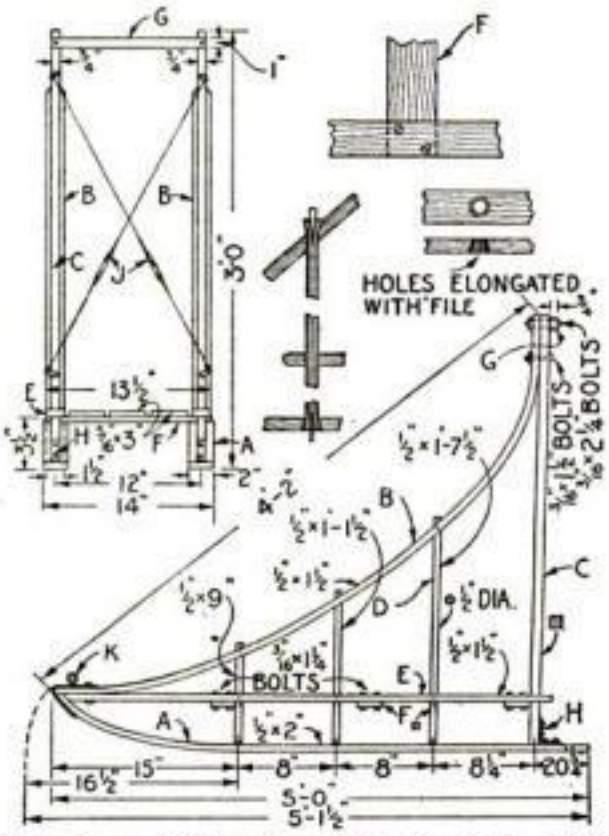
SHAFT straighteners are useful for the machinist who is working with stock of small diameter. A powerful type of straightener is that illustrated. The parts are hand-forged machine steel. The horizontal bar has a trunion on each end for supporting the hooks and a hub in the center which is bored and threaded to receive the screw. The end hooks are held on by means of nuts, or with washers and cotter pins. The screw should be made of nickel or tool steel and hardened on the end.—H. L. W.



Shafts up to 1 in. in diameter can be straightened by this method.

Building a Small Size Dog Sled

THIS easily constructed sled is a small copy of an actual Northern dog sled. Make two shoes *A* and top-rails *B* of white ash, though heavier wood will do



The plan and dimensions of the dog sled and the method of attaching side spindles and crosspieces.

if ash is not available. Soak these in boiling water for an hour or so. Lay out the curves on a long board and drive nails or place fitting blocks to hold the stock in shape while drying. Bend each piece and let it stay for twenty-four hours. Lay out the entire side on the floor, and fit the back post *C* and the ½-in. spindles *D* to the sled and top-rail. Make the spindles of cleft wood if possible for additional strength. Note that *C* and *D* slant backwards, which will demand some care in boring the holes. Make the spindles square between the shoe and seat rail to help support the latter. Drive small nails or screws through the joints when assembling the sides, boring holes if necessary to prevent splitting the wood. Be sure the spindles are flush with the bottom of the shoe. Join the sides with crosspieces *F*, using stove bolts, and fasten hand piece *G* with bolts of sizes given. Trim the top of each rail *B* to fit the top of *C*, and of shoe *A* to the width of *B*. Bend a piece of No. 25 gage galvanized iron 1½ by 7½ in. and fit to the front as at *G*, and a ⅝ by 2 in. inside angle iron at *H*.

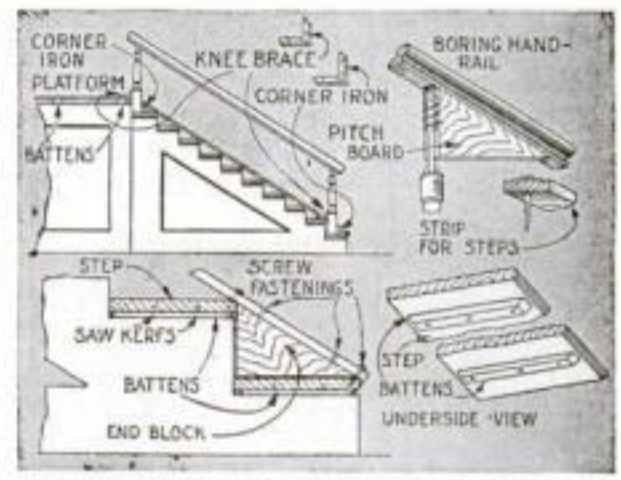
Make the seat of three pieces ⅝ by 3 in. by 2 ft. 6 in. and fasten with 1-in. trunk or clincher nails. Fit wire braces as shown, with turnbuckles *J*. With file and sandpaper round all corners and give one or two coats of varnish. Fit a stout eye at *K* to receive the traces. If desired the sled may be shod with light steel runners.—CHARLES A. KING.

Making Steps Safe in the Winter

HARD-SURFACED steps are always a source of danger during the icy winter months. The wooden storm steps illustrated not only give a surer grip but supply a handrail for added safety. They can be set up and taken down easily, and can be stored compactly during the warm months.

The platform is made of 1 by 4 in. sound-knot white pine tongue-and-groove flooring, or other wood suitable for outdoor construction. The platform is built on battens, ⅜ or ½ by 4 or 5 in., and is attached to them with nonrusting screws. Paint all joints before assembling.

The treads are made from 1⅛ by 10 or



Two saw kerfs are placed in the underside of each step to prevent any warping of the wood.

12 in. stock with one "nosed" or rounded edge, which can be procured at any woodworking mill.

If a circular saw is handy, it will be well to saw two kerfs along the underside of each step, to prevent warping. From ⅝ to ¾ in. is a good depth for these cuts. The steps must have two battens as shown, and more if they are long.

Put the platform and steps in place and attach the two long molded or plain-edged 1 by 2½ in. strips as shown. On the rail side of the steps this strip is placed in about 4 or 5 in. to allow for the newel posts.

The newel posts should be about 4 in. in diameter; and, if turned, the base should be left square for a length of about 9 in. to allow for the angle or corner braces. Do not make the rail too high; from 30 to 32 in. is the proper height when measured from the front edge of the step.

In boring the handrail to receive the upper ends of the newel posts, it is well to use a pitch board as shown.

Sometimes, for additional strength, end blocks are cut and fitted in the corner of each step.—A. E. ELLING.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

ONE of the best ways of making plaster casts of medals, figures, or ornamental objects is to prepare the molds in wax. A special wax for taking impressions is a mixture of 4 oz. of beeswax and 1 oz. of olive oil, melted together. To this is added 4 oz. of sifted starch, which is worked into the liquid until the whole takes on a doughlike consistency. When cold the mass is quite hard.

To use the wax, take a sufficiently large piece and warm it. Then make an impression of the object, being sure to moisten the metal before it is pressed into the wax. When cold, gently tap the reverse of the wax and the metal will fall out. Plaster of Paris and water may be poured directly into this mold. This method will give a perfect replica in the metal, and a number of copies can be easily prepared.

A wood composition which not only sticks but glues as well may also be made with the aid of wax. It is a plastic material of such a character that it may be worked like plaster of Paris. This preparation is made by melting and mixing thoroughly one part of beeswax and one part of common rosin, by weight, in a metal or porcelain dish—one which may be heated. Remove the mass from the fire and slowly add one part, by weight, of turpentine. Then mix in fine sawdust until the mixture must be kneaded with a pestle under slight heat to produce a uniform mass.

A Bunsen flame can be used for melting wax.

This plastic material, which will keep indefinitely, must be heated before use to a consistency easy to work with. It is adapted to all kinds of work; it will tighten tools in their handles, seal holes and fill cracks in wood, adhere to metal and to glass, and may be pressed into forms of metal or plaster of Paris. If pressed into plaster of Paris, the form should first be painted with linseed oil to prevent sticking. No matter for what purpose it is used, the best results are obtained when it is worked in under slight pressure.

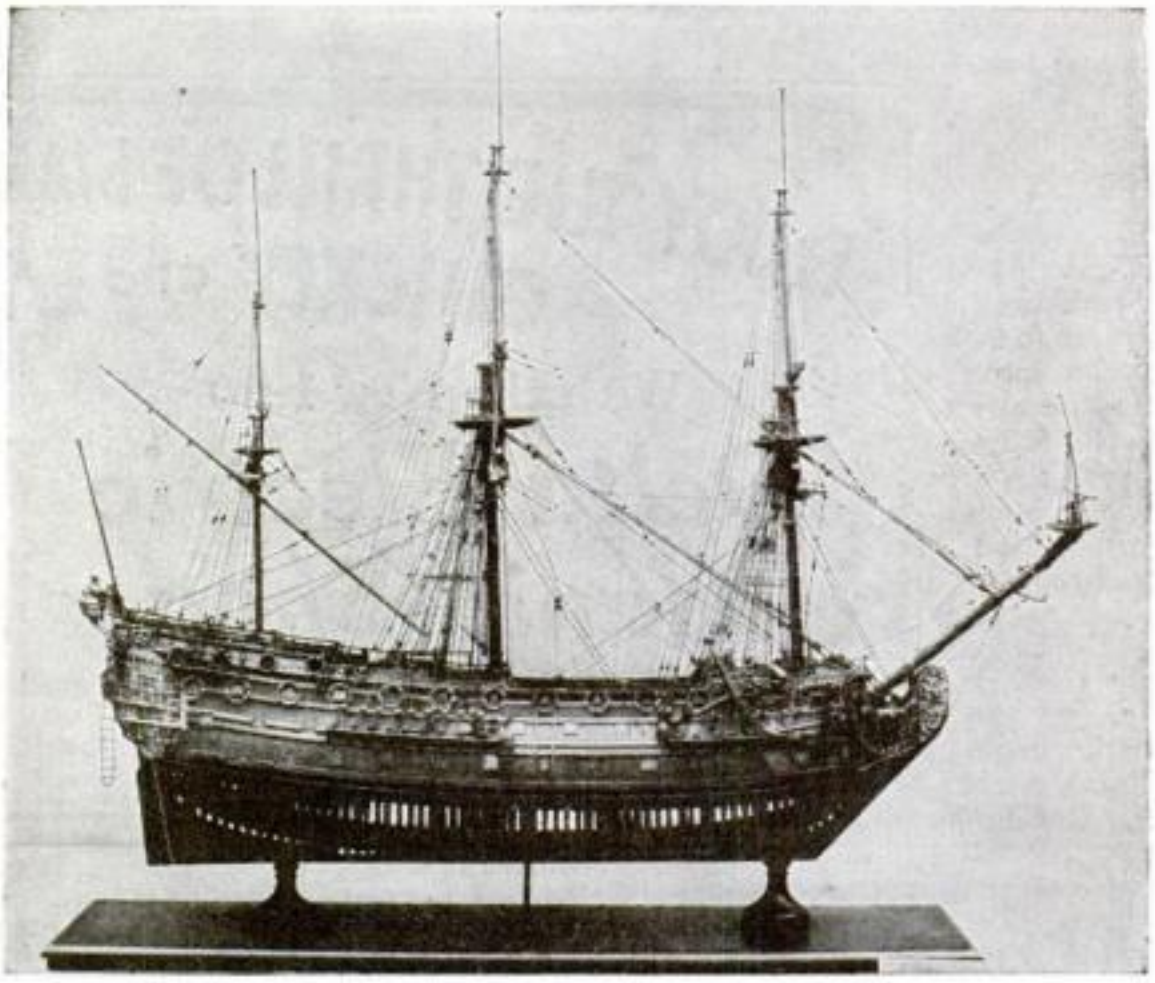
A waterproof wrapping paper may be made by dipping paper into the following solution and then hanging it over a string to dry. Dissolve 12 oz. of alum and 2 oz. soap in 2 qts. of water. Boil, add 7½ oz. of beeswax, and stir thoroughly.

A fixing fluid for charcoal drawings is prepared by dissolving beeswax in spirits of turpentine. This solution must be applied to back of the paper.—H. BADE.

A Base *for* Your Ship Model

You Can Set the Hull on Posts or Miniature Launching Ways, or Even Give It the Appearance of Being Afloat

By E. ARMITAGE McCANN



The post type of base with bilge shores supports this 48-in.-long dockyard model of the three-decker battleship *St. George, 1701*—Chuckfield collection.

FOR the ship models we have made together through the medium of POPULAR SCIENCE MONTHLY, I have in all but one instance suggested bases or stands consisting of two uprights that grip the keel and more or less embrace the hull, with a horizontal board or stick to hold them apart. These have been advocated because they are simple to make and adequately support the models without obscuring their lines to any great extent. There are, however, other conventional types which may be preferred by some model-makers.

One kind that is a favorite because it leaves the hull entirely clear consists of two turned posts with slots in them to take the keel only (Fig. 1). These posts are screwed to, or let into, a baseboard. Their diameter at the widest should be about one half the beam of the hull; their height, about one half of the depth of the hull.

Those who have a lathe can turn them readily, but it is always possible to find something suitable from which to make them, such as a pair of inexpensive candlesticks or the turnings from a discarded chair.

The keel must be firmly fixed to the hull; the slot should fit the keel very neatly; and the baseboard must be substantial, to prevent tipping over. If a model is to be placed high up or far back on a shelf, this kind of mounting is especially suitable, for the models can be raised as high as necessary to make the hulls fully visible.

Another not uncommon form of base represents the hull as if lying on the blocks of launching ways or a dry dock (Fig. 2). From twelve to twenty supports will be needed, and they should be not more than one quarter the height of the hull. The top section of at least three of them should be fastened with screws to the hull and then screwed firmly down to hold the model upright. For clipper ships the blocking would be uniform throughout the length, but for hulls which have a "drag," that is, are deeper aft than forward, the blocks should be arranged as shown so that the water line will be level.

Note that a shore is placed on either side, running from near the edge of the base to the bilge. These shores may be of wood, but brass bars are better. If a minimum of base is desired, the large flat baseboard may be omitted and a long center bar used instead, but it should have a crossbar half-lapped into it at the point where the shores are placed.

While I have advocated models that show the whole hull, because it has been proved by experience that water-line models do not give such permanent satisfaction, there is a way, nevertheless, of mounting models with sails by which the whole hull may be retained together with the picturesque effect of sailing. The hull is sunk up to the water line into a hollow base, either upright if the yards are squared, or leaning over if they are braced up, as with the wind in one side.

A method giving a most realistic effect is to obtain a piece of rippled blue or green glass and have a hole cut in it to take the hull. For support, cement the glass to a thin hardwood or three-ply board, similarly cut out. Fasten this to four or more short pillars, which in turn are fixed to a baseboard, as in Fig. 3. The effect is heightened by adding bow waves, side ripples, and waves and a stern wake of gesso, painted white.

Glass of this kind is not to be found everywhere, and the cutting requires skilled work. The water-line template can be used for marking the opening if the model is to be upright, but another will have to be drawn and carefully fitted to the hull if she is to lean over.

A somewhat similar effect may be had by omitting the glass and

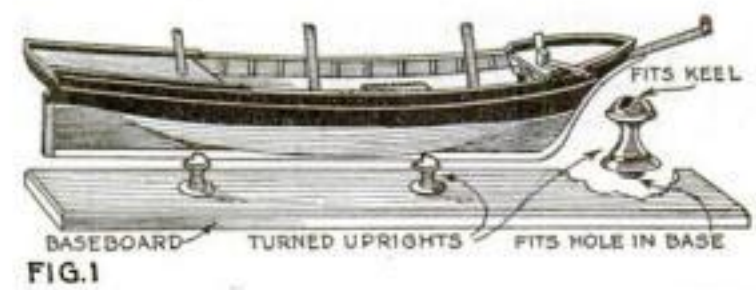


FIG.1

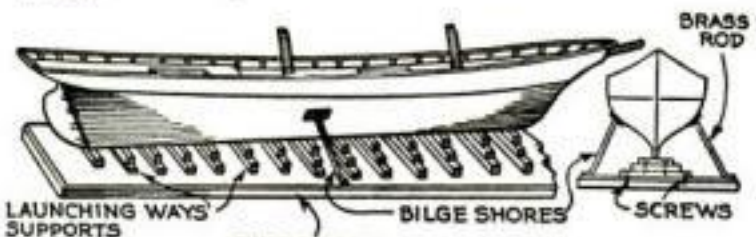


FIG.2

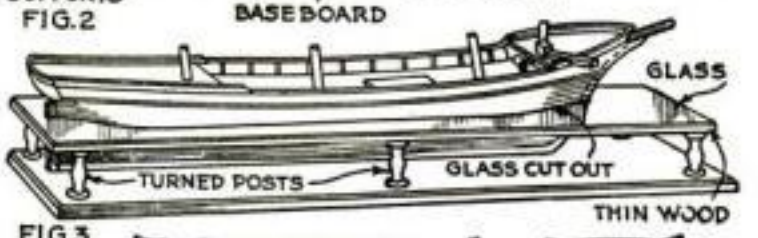


FIG.3

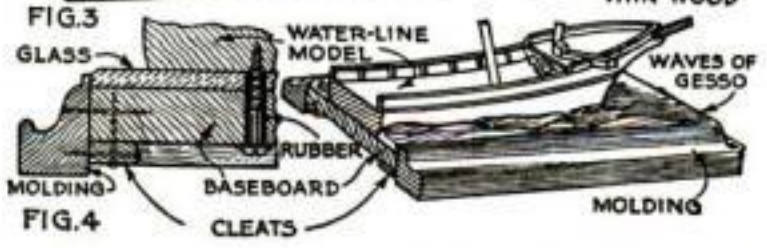


FIG.4

Three methods of mounting models so as to reveal the whole hull, and two ways to support water-line models.

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molding gesso waves on the upper board mentioned, which should then be a little thicker; or the waves may be carved out of the board.

If the model is already of the water-line type or you do not object to cutting it off to that line, then mounting it is a simple matter. I mounted one old model by getting a piece of blue glass and having it beveled at the edges, drilled in the corners and with holes on the center line, and then silvered. The holes in the glass always must be sufficiently large to allow thin rubber tubing to be placed on the screws in order to prevent contact between the steel and the glass.

I cemented the hull to the glass with Canada balsam and drove screws through the two central holes in the glass. Then I screwed the glass to a piece of ½-in. walnut, polished on the edges and the underside.

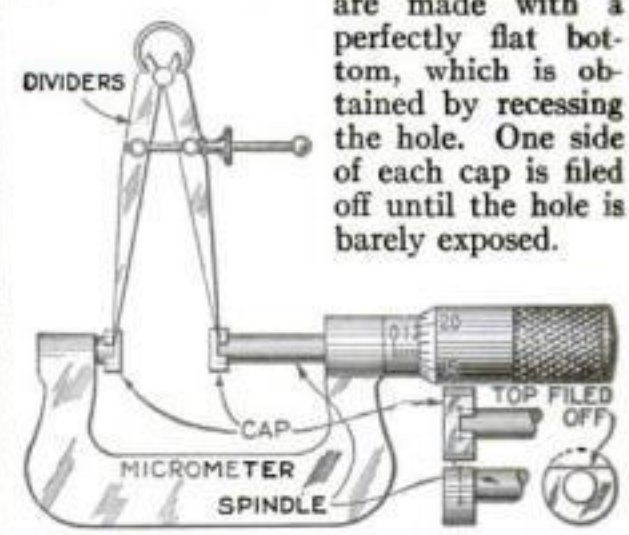
In place of the glass a model may be screwed to a board on which are gesso or carved waves.

Frequently a water-line model looks better if raised a bit to give the suggestion that the rest of the hull is there. To get this effect, raise either of the above bases on a picture frame or similar molding, mitering the corners to fit—edge up—as shown in Fig. 4.

Setting Dividers Exactly with a Micrometer

IN THE absence of a vernier height gage for scribing lines accurately or in the event that such a gage cannot be used, dividers may be set very precisely with micrometers.

To aid in setting the micrometers, two caps are made to fit on the end of the spindle and on the anvil as shown. They are made with a perfectly flat bottom, which is obtained by recessing the hole. One side of each cap is filed off until the hole is barely exposed.



To aid in setting the dividers two caps are made for the micrometer spindle and anvil.

When a cap is fitted in place, the end will be marked by a line, one side formed by the spindle, and the other by the flat bottom of the cap. The same is true of the anvil. The dividers can be set to these lines. For extremely accurate work, a magnifying glass may be used.

By having a pair of these caps in his kit, the toolmaker is assured of being able to set his dividers accurately without any calculation.

DRAWINGS and blueprints may be easily and quickly cleaned with ordinary wall paper cleaner. Keep the cleaner in a closed container, for it dries out readily.

How Sticking Doors May Be Remedied

What should be done when a door sticks?

GENERALLY, a well-hung door in a well-built, well-seasoned house will cause little trouble; but when the furnace heat is on in winter and during the heat and humidity of summer, the best of them are likely to forget their manners.

Fig. 1. If the top of a door does not stick badly, it can be eased by planing the top.

The first step before easing a door is to investigate and locate the trouble. Sometimes the sticking is so slight that the rubbing of a paraffin candle or hard white soap on the offending point will relieve it sufficiently.

How may sticking at the top be remedied?

If the top of the door does not stick too badly, it may be eased by using a plane as in Fig. 1. Hold the door by a wedge at the bottom as at *A*, Fig. 3. First plane a light shaving from each side or corner edge of the top of the stile to prevent splintering the wood. Then carry the plane straight on the top of the door as illustrated and not at an angle, which would probably tear ugly splinters from the sides of the stile.

If more than a few shavings are to be removed, it will be better to take off the door. If the door is hung with loose joint butts (hinges) as at *B*, Fig. 3, it may be opened and lifted off its hinge easily. If hung with loose pin butts as at *C*, the pin may be lifted out with the aid of a screw driver or a nail set and hammer, should the fingers alone be unable to start it. Remove the pin from the bottom butt

first, so the top butt will hold the door. In planing the door, hold it between the knees as in Fig. 2.

What is the cure for tightness at the bottom?

If the bottom end of the lock stile strikes the threshold, the door should be removed and the same treatment applied. However, there is another way to remedy the difficulty. Note the space between the front edge of the door and the jamb; if it is not less than 1/16 in., the sticking may be reduced and perhaps cured by

Fig. 2. To plane a door that sticks at the bottom, it must first be removed from its hinges.

manipulating the hinges. Back the screws of the bottom hinge out a little and insert a narrow piece of pasteboard under one or both butt flaps as at *D*, Fig. 3; or better, a wide piece as at *E*. This cannot be done, obviously, if it makes the front edge of the door bind against the jamb.

When a floor is uneven, and a door drags on it, usually the front stile may be lifted above the floor by setting the lower hinge out a little as at *F*, Fig. 3, or a wider hinge may be used, in which case the hinge will fill the recess made for the original butt. If the door has three hinges, the middle hinge should be set out so the three pins will be as nearly in line as possible, although at best there will be some strain on the hinges. The spaces *X*, made by moving the original butt, will be seen only when the door is open, but they should be filled with a carefully fitted piece of wood and finished to match the adjoining wood.

Can a wooden threshold be used to remedy this defect?

Another solution of the uneven floor problem is to fit a threshold or "saddle" 1/2 or 5/8 in. thick, provided there is no objection to having this slight division between the rooms. Before taking the door down to make this addition, set a compass a trifle wider than the thickness of the threshold and mark (scribe) both

sides of the door at the bottom; then cut the door off to the line.

What should be done when a door sags because the upper hinge is loose?

If the screws in the top hinge have pulled out of either the door or the jamb,

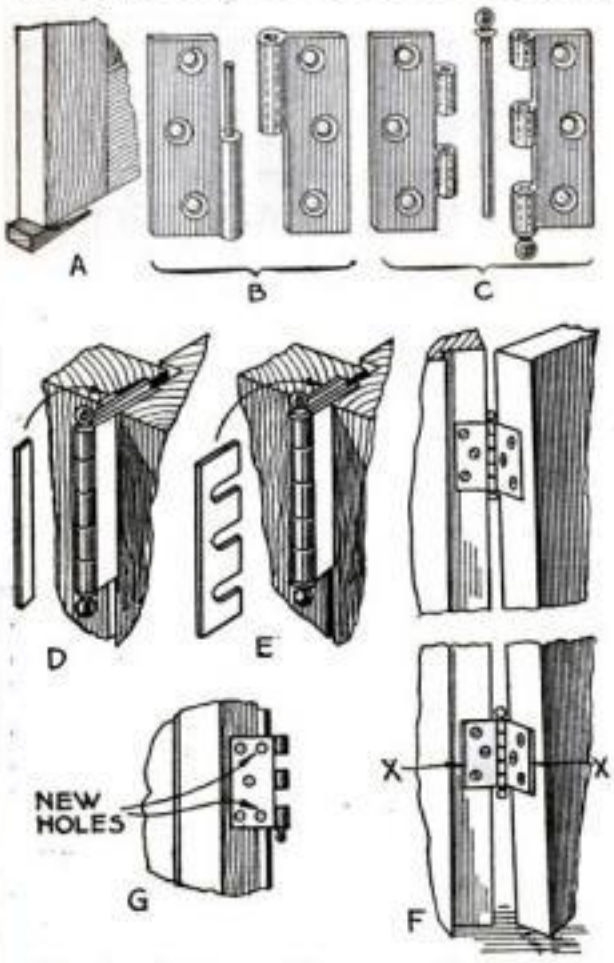


Fig. 3. *A*, the use of a wedge. *B* and *C*, two types of hinges. *D* and *E*, hinge inserts. *F*, shifting lower hinge. *G*, new holes.

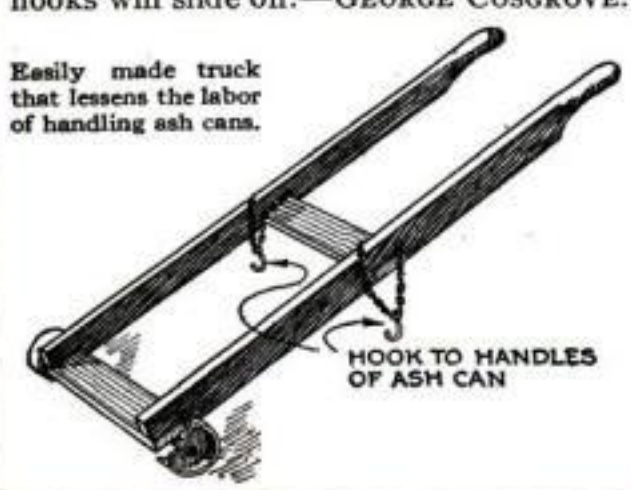
longer screws may be used; or the old screw holes may be filled with a plastic wood composition or a glued-in plug, and the screws turned in again. Sometimes the top hinge of a heavy door may be made to hold only by driving long, slender screws through the jamb and into the studding.

If, as is often the case, a plug, does not give promise of holding and the screws reach back only into lath and plaster, as with many doors having narrow butt hinges, the hinges themselves may be drilled and countersunk in line with the center of the door casing and a firm hold obtained, as at *G*, Fig. 3.—C. K.

Simple Ash Can Truck

BECAUSE ash cans are heavy and awkward to handle, and rolling them on the concrete walk bends the bottoms, I made a truck as shown below. If desired, more crossbars can be added.

The hooks are fastened to the handles of the ash barrel. To unload, all that is necessary is to let the barrel down, for the hooks will slide off.—GEORGE COSGROVE.



Easily made truck that lessens the labor of handling ash cans.

Odd Ornaments Made of Coconut Shells

By A. E. McCALL

BY SMOOTHING coconut shells with a file and sandpaper, they can be brought to a finish similar to that possible on hardwood. The attractive ash tray, book ends, loving cup, candle lamp, and electric lamp illustrated were made almost entirely of coconut shells finished in this manner.

The electric reading lamp is constructed from two coconuts, a light socket, valve and cap from an old inner tube, and a piece of electric light cord. A coconut having a 6-in. diameter is used for the shade. A wire clamp is bent to fit over the lamp and when bolted to the shade

Ash tray, loving cup, and candle holder made from coconut shells which have been smoothed.

serves to hold it in place. The valve stem and dust cap form the stem of the lamp.

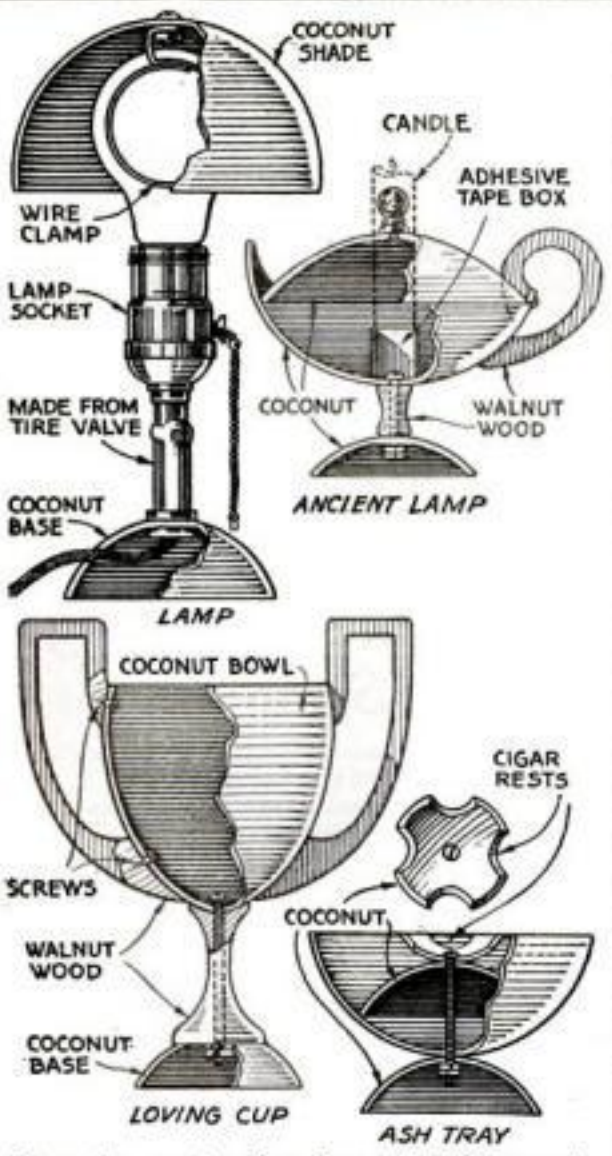
A loving cup made from two coconuts and walnut wood forms a unique trophy. Use a coconut with a pointed end and tapering sides for the bowl. Cut two handles from walnut wood and attach them to the bowl with brass screws. Turn the stem in a lathe, and by means of a 3½-in. stove bolt fasten the bowl and base to the stem. A shield of copper may be riveted to the bowl with copper wire.

Any one who smokes will appreciate an ash tray made from coconuts. Two small coconuts and two large ones are used in the construction. The base and the rest for the cigarettes are made from the small coconuts, the rest being either round or square, and has grooves cut with a half-round file. Make the bowl large, and fit an inverted shell into it so that its edge is about 1½ in. from the top. A stove bolt through the center will hold all of the parts in place.

Coconut shell reading lamp and book ends.

You can make a candle holder from a small coconut, a large coconut which seems "cranksided," and small pieces of walnut wood. Make the base from the small coconut and the bowl from the large one. Use the walnut wood for the handle and the stem. Attach the handle with brass screws and run a bolt through the center to hold the base and bowl on the stem. A small adhesive tape box on the top end of the bolt will serve to hold the candle. To secure the effect of an ancient lamp, remove the candle and place a cover on it. A small brass knob adds a

A definite program for getting ahead financially will be found on page four of this issue.



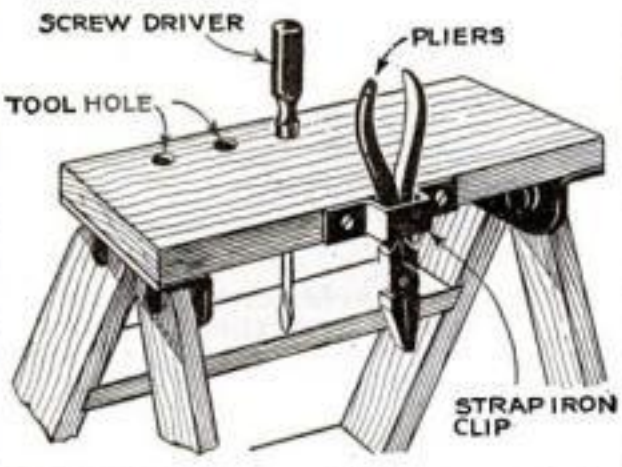
Plans for constructing four unusual coconut craft objects with very little effort and expense.

finishing touch to the coconut cover.

In making the book ends, saw off the ends of a large coconut, leaving about two thirds of the shell. Cut this in half, cut out any design preferred, and shape a piece of wood to fit inside the hollow shell. The design suggested is a windmill scene in which the clouds and windmill stand out in relief against the wood, which has been painted blue to represent the background of the sky and the sea.

Any rough spots that appear on the surface of the shells can be removed with a file. The shells should then be sandpapered thoroughly and finished with ordinary wax or polish.

Tool Rack for Stepladder



BY BORING several holes towards the front of the top step of your stepladder and adding a clip or two on the back edge as shown, it is possible to make a convenient rack for tools. When one is working on a stepladder, such a rack will be found very convenient, for merely laying the tools on the top step often results in a trip down the ladder to retrieve something that has fallen to the floor.—R. WAILES.

A definite program for getting ahead financially will be found on page four of this issue.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

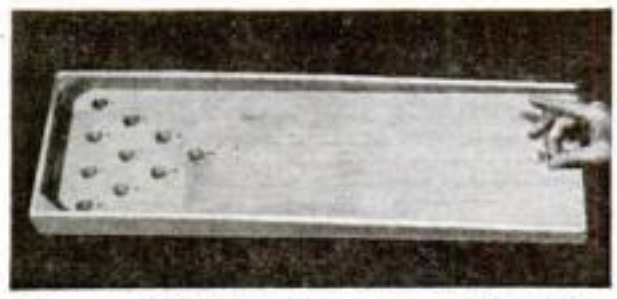
Easily Constructed Toy Bowling Alley

THE miniature bowling alley illustrated is easily built and when completed provides means for playing an interesting game.

Clear, select pine is the wood most suited, but any available wood will serve the purpose.

The board for the alley is brought to size first, and then the holes are laid out on the sides of an equilateral triangle, as shown. The holes are made with a countersink and numbered to correspond with those given in the diagram.

The end and side pieces are fastened in place with brads and glue.



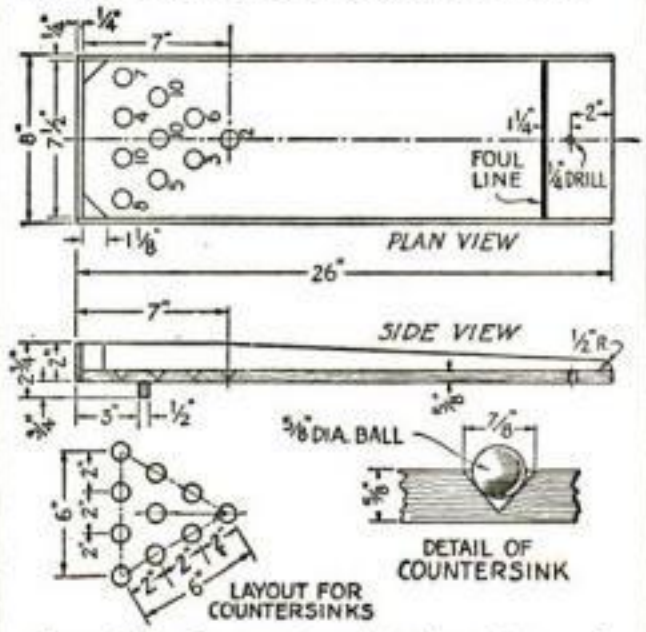
The completed alley forms a game that will give entertainment to both young and old.

The alley is sandpapered and then given two coats of orange shellac, being thoroughly sanded between coats. A good finish on the alley is an important part of the construction.

A ½- or ⅝-in. marble is used to play the game. Each player is given two throws, as in tenpins, and the rules are similar, only the score is determined by the numbers on the various holes.

In keeping the score, it should be borne in mind that when the total for two balls is ten or more the score is counted as a spare, as in tenpins, allowing one extra throw. In the tenth frame a player making a strike is entitled to two extra throws as usual. Should he fail to get a strike on the first but a total of ten or more for the two balls, it is counted as a spare, allowing one extra throw.

This project, by George Dally, an instructor at Boys Technical High School of Milwaukee, Wis., was awarded second prize in the elementary woodworking division of a shop problem competition conducted by the Educational Department of POPULAR SCIENCE MONTHLY.



Layout for the countersunk holes and general plan for the construction of the pinless alley.

Advice for POPULAR SCIENCE MONTHLY readers regarding safe and profitable investments. See Page 4.

Soft Soldering Art Metal Work by Direct Heat Method

By EDWARD THATCHER

MANY fine pieces of decorative metal work have been ruined in the last stages of construction by the inability of the worker to do good soldering.

Of the many solders used in art metal work, soft solder is probably the most serviceable and the easiest to handle.

Metal must be clean and bright before it is joined with any form of solder, and it must be kept that way. To do this a "flux" is used. For soft soldering, compounds containing rosin, or pastes made up of petroleum bases, and killed or cut acids, are used as fluxes. These are spread on the joint and on the clean solder before applying the heat. The fluxes melt over the solder and the joint and do not burn off when the metal is brought up to the melting point of the solder, thus keeping the metal clean. For hard soldering and brazing, employing the intense heat that they require, some form of flux such as borax is used. This melts over the joint in the form of a glasslike coating and thus protects it from oxidation.

The box shown is made of No. 20 gage copper and presents ideal problems in soldering. Sheet copper of about this gage may be obtained with one side coated with tin. This tinned lining makes it possible for the box to be used as a sugar bowl, powder puff box, etc. However, if you wish to make one like it of plain copper or brass, you may have it silver plated inside, or coated with aluminum paint or lacquer.

The shape of the patterns for the various parts of the box are shown in Fig. 1. The oblong strip of copper *A* is bent into cylindrical form over an anvil. Bend it with the hands and true it up with a wood-

A copper box is an instructive problem in soldering as accomplished by direct heating.

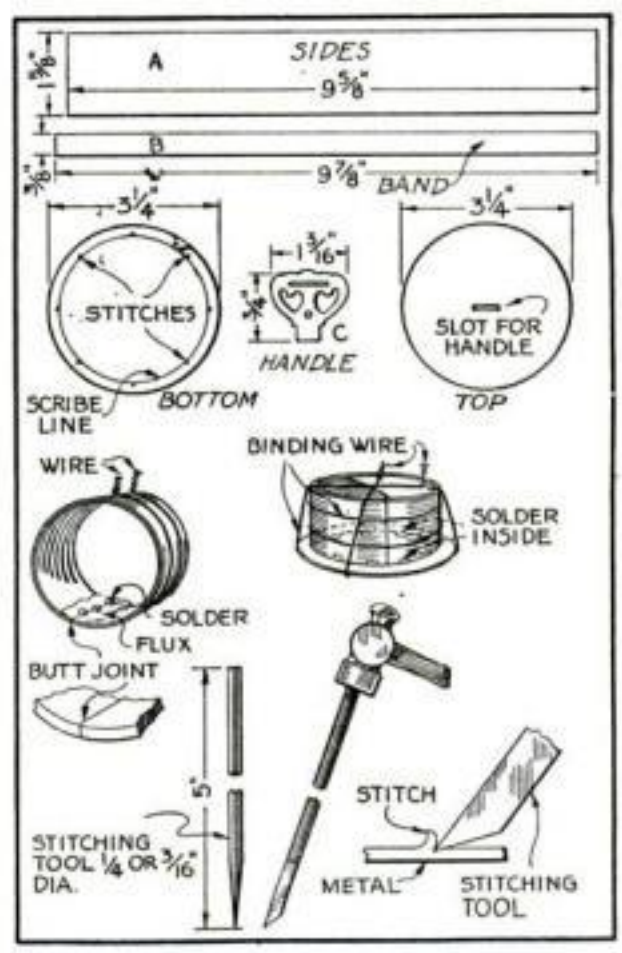


Fig. 1. Dimensions of the various parts, method of stitching, and the stitching tool.

en mallet. Test it for roundness by placing it over a circle drawn on cardboard. See that the ends are cut square across and come together evenly in a butt joint.

Before soldering the joint it must be tightly bound together with some No. 20 iron binding wire. Be sure that the ends of the piece where they butt together and the metal on both sides of the joint for at least 3/16 in. is made clean and bright.

Killed acid flux is about the best for this work. It is made of pure zinc dissolved in muriatic acid. Practically pure zinc may be obtained from the shells of old dry or flashlight batteries. Cut up a small handful of ¼ in. square zinc clippings. Set an old coffee cup in a pan of cold water to absorb the heat generated by the chemical action and carefully fill the cup one third full of muriatic acid. Then add about a half teaspoonful of the zinc clippings to the acid. When the bubbling has subsided somewhat, add another small amount of the zinc clippings and continue this operation until no action is set up, showing that the acid is saturated with as much zinc as it will take up. Let the solution stand for several hours and then strain out the zinc and dirt through muslin, draining the killed acid into a jar having a tight glass or wooden cover. Personally, I use the killed acid without dilution, though some workers add water, alcohol, or glycerin to it.

Apply the flux on both sides of the joint and as shown in Fig. 1. Use solder in wire form, and cut it up into about ⅛-in. lengths. Place these pellets of solder along the joint and cover with flux.

Now apply the heat as shown in Fig. 2. Take care to apply an equal amount of heat on both sides of the joint. If you apply the flame directly to the small bits of solder, they will roll up in a ball.

A red heat will burn off the flux and oxidize the metal and the solder. Soft solder will melt on metal long before the metal reaches a red heat.

No matter how tightly your work is joined and tied together, the solder will run between the joint. You should leave

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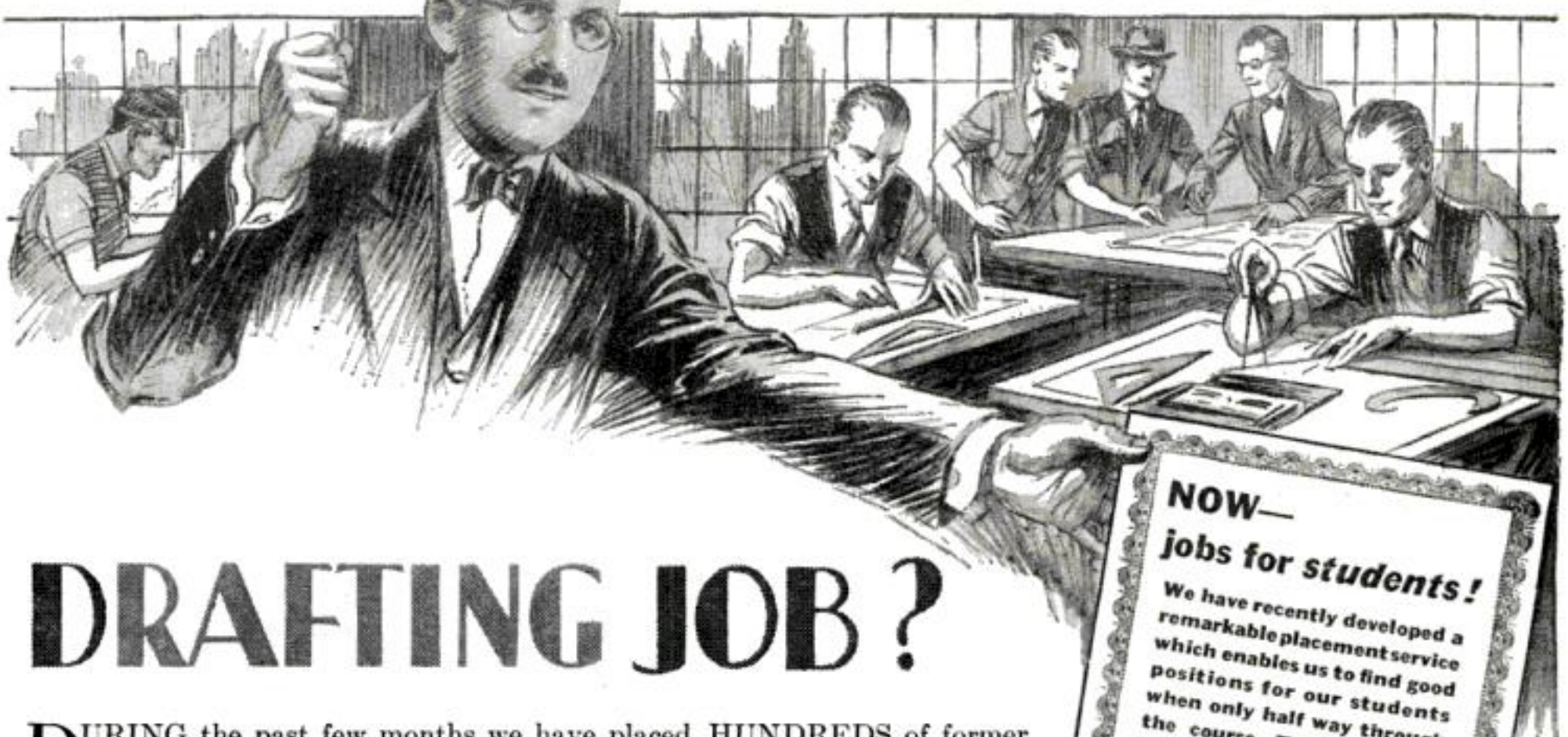

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no gaps or cracks for the solder to fill.

True up the cylindrical form that you have already soldered, but leave the binding wires in place to hold the first joint together while you solder on the bottom. Clean up all edges to be soldered. Use dividers to scribe a circle on the bottom plate, the circle being just slightly larger in diameter than the cylinder.

Before soldering the bottom in place raise up some little points of metal on the bottom around the scribed circle to help hold the cylinder in place. This is called "stitching" and is done with a tool like that shown in Fig. 1, which may be made of tool steel or fashioned from an inexpensive scratch awl by grinding the end to shape. The point of the tool is driven lightly into the metal, so as to raise up a small projection. Bind the joint and apply the solder and flux as above. Paint the old joint with a mixture of yellow ochre

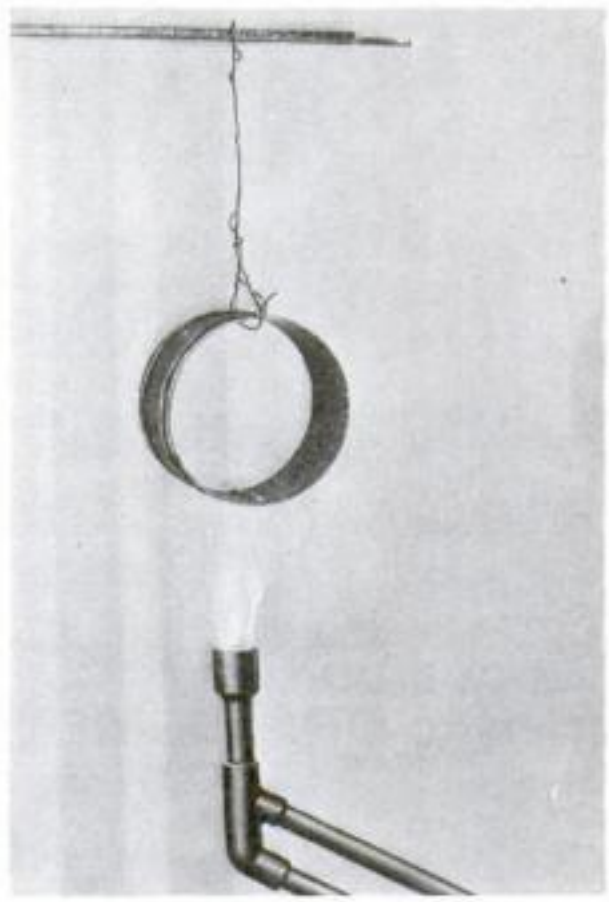

Fig. 2. Soldering the butt joint in body of box. Note the binding wire holding the joint.

and water. This will protect the solder and, to some extent, keep it from melting when the heat is applied.

For this second joint, the heat should be applied underneath, as shown in Fig. 3. However, while most of the heat should be directed underneath the work, the upper part should also be heated, the object being to heat both the bottom and the sides near the joint to an even temperature. If, for some reason, some of the solder does not melt and run into the joint, touch this part with a brush full of flux while the solder is molten; or add more solder by taking a length of soft solder wire, dipping it into the flux, and touching the joint with the fluxed end. In soldering such a joint, do not direct the flame on the bits of solder; though you may occasionally direct the flame inside of the work to advantage.

You will find that the solder always tends to run to the hottest part of the work. Although your solder may melt, if one side of the joint is hotter than the other side the solder may all run to that side of the joint.

The top can be domed up in the center

Coming Features

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Homemade Attachments for a Small Lathe

Quickly Made Block Puzzles

How to Test the Quality of Paints

Constructing a Modernistic Radio Cabinet

as shown. A narrow strip of metal is cut for the band which is to be soldered to the lid to fit either inside or outside of the box, as desired. This band is rounded up and soldered together just as you made the body sides of the box. The band is soldered underneath the lid in the same way the sides were soldered to the bottom; don't forget to leave the binding wire about the band and to bind the band tightly to the top. Stitches are taken under the top to hold the band.

The knob, Fig. 1, is sawed out of No. 14 or **No.** 12 gage sheet copper. It may be attached to the top by riveting over the end of the tang, or the tang may be soldered to the underside of the top. It should fit tightly into the slot, which is drilled and filed out for it. If soldered, apply the flux and solder as before and heat the metal near the tang of the knob.

When soldering is done in this way, the solder flows into the joint neatly, leaving little or none to scrape away. Excess

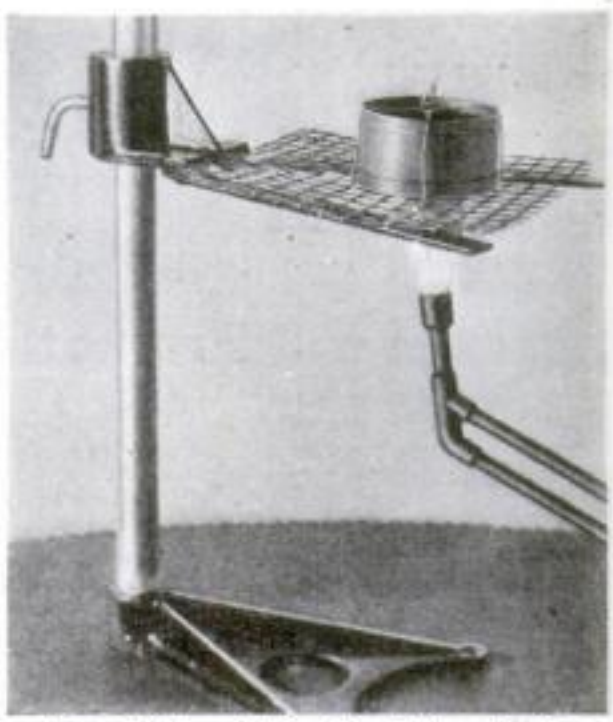

Fig. 3. When soldering the bottom, bind the first joint also, so as to hold it together.

soft solder may, however, be scraped away with a small scraper made of tool steel. Do not file away solder with a good file as the solder will clog it up. There are special files made for such soft metals.

Lines of solder will, of course, show at each joint, but these can be covered by either painting or copper plating.

A Modern Lamp Cheaply Made

By VERA B. EDWARDS

A cardboard mailing tube forms the shaft of this unusually decorative modernistic lamp.

WHILE the table lamp illustrated possesses distinction and grace, it is so simply designed and made of such easily obtainable materials that the handy home craftsman can proceed in its construction with celerity and precision.

The materials needed are: *A*—1 pc. ¾-in. white pine, 5 by 5 in.; *B*—1 pc. ⅜ by 2½ by 2½ in.; *C* and *D*—2 pcs. ⅜ by 2 by 2 in.; *E*—1 pc. ⅜ by 1¾ by 1¾ in.; *F*—1 cardboard mailing tube, 1 in. in outside diameter; *G*—1 electrician's bushing; 1 sheet heavy, rough drawing paper; 1 wire shade holder; 6 decalcomania (transfer) panel ornaments; and felt, liquid glue, and quick drying lacquer (ivory and black).

From *A*, *B*, and *C* cut hexagonal blocks for the base of the lamp as shown in Fig. 1 and in the center of each bore a hole 1 in. in diameter. Sandpaper the parts and glue them together. Lacquer the edges of the block *A* black, and the upper surface ivory; color block *B* ivory and block *C* black.

Cut the tube *F* the desired length and make a hole 2 in. from the bottom to receive bushing *G*. For the top of the column make two hexagonal pine blocks *D* and *E* (Fig. 2). Bore a 1-in. hole in *E* (it is best to do this before cutting the hexagonal shape), and bore a small one in *D* to receive snugly the small threaded end of an ordinary pull-chain lamp socket.

Sandpaper and lacquer the edges and bottom of block *E* black; sandpaper block *D* but do not apply any finish. Glue the bushing in the tube, glue the tube in the hole in the base blocks, and glue block *E* on squarely at the upper end of the tube, as shown in Fig. 2. Do not yet glue *D* in place.

To make the shade, lay out two circles as illustrated in Fig. 3 and draw two lines from the center, each at 30° from the vertical center line. Make an allowance at one end for a ½-in. gluing strip. Decorate in ivory and black as indicated and add a decalcomania ornament in each panel.

When the lacquer is dry, cut out the paper, spread the lap with glue, and over it press firmly the opposite end. Lay the glued joint on the table and weight it heavily until dry.

In assembling the lamp (Fig. 4), draw the electric cord through the bushing, on through the tube, and out through the hole in the cap *D*. Glue on the cap *D* and finish its exposed surface in ivory color. Connect the cord to the socket and glue the screw thread in the hole in block *D*.

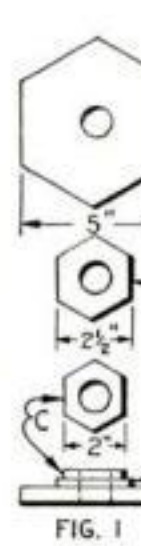

FIG. 1

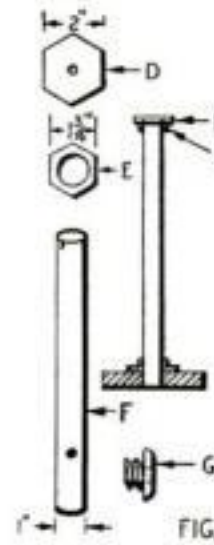

FIG. 2

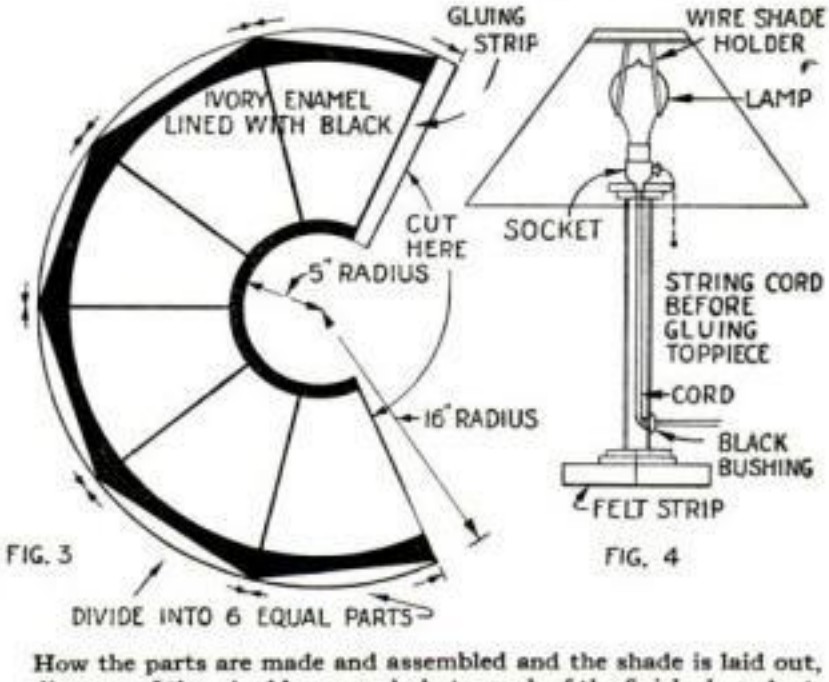

FIG. 3 FIG. 4

How the parts are made and assembled and the shade is laid out, diagram of the wired lamp, and photograph of the finished product.

Andirons Form Ideal School Project

AS EITHER an individual or a school shop project, the andirons illustrated should prove interesting. Almost every home, even apartments, are now being built with at least one and sometimes two open fireplaces, which must be supplied with andirons.

The design illustrated was submitted by George Gordon, Jr., an instructor at the Congress High School, Bridgeport, Conn., and won first prize in the advanced metal working division of a shop problem competition for teachers conducted by the Educational Department of POPULAR SCIENCE MONTHLY.

The front units, or decorative part of the andirons, are cast from brass, while the log rails are forged iron and the strain rods and bars are malleable steel.

The general layout and the proportions can be ascertained by a study of the photograph.

If care is exercised in the planning of the operations, this project can be made an ideal problem for the school shop. Any boy will work hard if he knows that the result of his efforts will be something useful, durable, and attractive.

Because of the fact that the detail drawings as submitted by Mr. Gordon were so thorough and complete, it is impossible to publish them within a column width and have them large enough to be readable. However, photostats of the author's original drawings along with a bill of materials can be obtained by sending twenty-five cents and a request for the Andiron Photostat to POPULAR SCIENCE MONTHLY, 381 Fourth Ave., New York, N. Y.

Both attractiveness and durability are combined in this well planned, prize winning design.

New Clues to the Mayan Riddle

(*Continued from page 23*)

nessmen, and artisans of an advanced culture.

Along trade routes comparing favorably with those of the ancient Phoenicians and Sumerians, Mayan merchants imported pearls from Colombia and turquoise from distant New Mexico, and exported their native pottery and woven textiles in exchange.

AS AGRICULTURALISTS, the Mayas probably surpassed most of their farming contemporaries across the Atlantic. Their cultivation was intensive; their crops were widely diversified. To them the modern world owes its corn, potatoes, sweet potatoes, lima and kidney beans, cocoa, cotton, tobacco and a host of other cereals, vegetables and fruits, as well as a number of medicinal plants, including quinine, cocaine, and cascara sagrada. They were the first planters of rubber and the discoverers of chicle, which forms the basis of chewing gum. They originated the custom of sowing squash between hills of corn, and beans between rows of corn hills.

In many other ways the Mayas uncannily anticipated modern methods. They discovered the use of concrete in the construction of buildings. It appears that they erected wooden forms against which were laid blocks of stone, cut smooth in front only, to serve as a facing. Then a mixture of crushed rock and liquid mortar was poured into the space between the facing and the inner wooden form. This produced a strong monolithic wall. In their painting, they embodied the principles of perspective and foreshortening, and even developed a certain technique in presenting a three-quarters view. And devotees of the Sunday comics may be surprised to learn that the Mayas, in their carvings of human figures in conversation, originated the "speech-balloon" without which no modern "funny" is complete.

SOME of the Mayan domestic arrangements, too, were quite "up-to-date." On a certain day corresponding somewhat to our New Year's, a period resembling a modern "clean-up week" was inaugurated. For thirteen days every Maya was compelled to clean, repaint and renew his house from top to bottom and renovate all furniture and household utensils. The temples, especially, were subjected to a thorough cleaning-up process, supervised by the priests who were required to fast during the thirteen days. The close of the house-cleaning period was celebrated by the lighting of new fires upon the altars and general feasting in which, it may be imagined, the priests took a more than academic interest.

Among the Mayas the women did most of the farm work—no mean job when it is realized that they had no draft animals—and so it is safe to assume that the chores of "clean-up week" were also left to them. If the Mayan men were anything like the husbands of today, they probably were out on the tennis courts while their wives were scrubbing, painting and polishing.

For in the realm of sport also the Mayas were innovators. They enjoyed a game closely akin to squash or tennis, in which rubber balls were knocked back and forth across a court with the ancient equivalent of a racket. Only last year, Dr. Frans Blom, of Tulane University, New Orleans, discovered some of the ancient tennis courts in Yucatan. Although estimated to be 2,000 years old, the courts were in excellent repair.

Medicine was at a low ebb though there is evidence that the Mayas knew how to trepan skulls, and also may have had a knowledge of anesthesia. Dentistry of a sort was practised by Mayan surgeons, as evidenced by the discovery of teeth that were filed to fine points and others with fillings of shiny iron pyrites. In all likelihood,

(*Continued on page 127*)

New Clues to the Mayan Riddle

(Continued from page 126)

however, this early American dental work was performed for no reason other than to "improve" the patient's appearance.

But in no field of endeavor were the Mayas so far ahead of their time as in mathematics and astronomy. And it was because of their amazing command of these sciences that they were able to work out a calendar system which for accuracy equals and even surpasses our own.

ON JANUARY 1, 1930, the Soviet government of Russia introduces a new calendar featured by a five-day week. The year will have the usual twelve months, each consisting of six of the short weeks, while the five "spare" days will be devoted to national festivals. In America, George Eastman, the camera manufacturer, and other prominent business men are urging the adoption of a thirteen-month calendar. (P. S. M., June '29, p. 32.) The Russians, however, did not invent the five-day week, nor did the notion of a thirteen-month year originate in the United States. Long before the beginning of the Christian era, the ancient Mayas had developed and were using both.

According to Dr. Spinden, the Mayas probably first had a lunar-solar calendar of twelve months of thirty days each, making a year of 360 days. But, instead of turning the five "loose" days into holidays, like the Soviet calendar reformers, they made them into an extra, short thirteenth month. Later, the days in the month were reduced to twenty and the number of months increased to eighteen. This the Mayas did to make their calendar correspond to their system of counting, which was based upon the number twenty—the number of fingers and toes possessed by a human being. The short extra month, of course, had to be retained.

Although the Mayan day-count was not put into operation until August 6, 613 B.C., the Mayas projected time back to a date corresponding to October 14, 3373 B.C., which they considered the beginning of the world. So accurate was their calendar that from the time it was put into actual use until A.D. 1561, when fanatical Spaniards destroyed most of the books and chronicles of the Mayan Empire, it did not err to the extent of a single day. The old Julian calendar, which was used in southern Europe until 1582 and in Russia until a few years ago, made the year twelve minutes too long and accumulated an error of 11 days in less than 2,000 years. The ancient Mayan calendar, Dr. Spinden told me the other day, could have run for 300,000 years before it would have accumulated an error of one day. Our present calendar will run only 3,300 years before it gets to be one day wrong.

BY MEANS of an intricate system of names and numbers, the Mayas could distinguish any individual day within a calendar round of fifty-two years, the unit in which they kept their records. Besides, they created a "long count," in which they reckoned the lapse of time from the initial point—October 14, 3373 B.C. In this long count they measured time by "kins," or days; "unials" of twenty days; "tuns," or years of 360 days; "katuns" of twenty years, and "baktuns" of 400 years. In addition, they also used a "great cycle," but it has not been established with certainty whether this consisted of 5,200 or 8,000 years.

Dr. Spinden, who has made fifteen trips of exploration in the Maya country and devoted years to the work of correlating the Mayan calendar with our own, explained to me the psychology underlying the Mayan time-count.

"The idea of the immensity of space and time," he said, "seems to have got into the very soul of the Mayas. Their calendar was, you might say, a celestial (Continued on page 128)

New Clues to the Mayan Riddle

(Continued from page 127)

diary. They gave the days names and numbers not only to distinguish them in long stretches of time, but also to endow them with a personality. Thus, there were good days, bad days and indifferent days. Naturally, our mode of thinking about time is so entirely different and so impersonal and abstract, that it is a bit difficult to understand exactly what the Mayas tried to do. They attempted to reduce time to a point where it became more or less concrete and tangible. In other words, they wanted to 'feel' time and I, for one, am almost sure they could. Incidentally, Mayas had to be past middle age to have a chance to observe their birthdays, for the same day came back only once every fifty-two years."

THE Mayas' marvelous knowledge of the movements of the heavenly bodies was chiefly the result of their invention of what might be called "lensless astronomy." They had, of course, no telescopes.

A few years ago, Dr. Oliver G. Ricketson, Jr., of the Carnegie Institution, who was a member of Lindbergh's party on his recent flight, discovered that a round tower amid the ruins of Chichen Itza had been used by the Mayas as an astronomical observatory. To make observations of the stars and the planets, they used slits or windows cut through the walls of this tower at "strategic" points. By making careful note of the particular opening through which the sun shone at high noon, the observers were enabled to fix the dates of the spring equinox, the summer solstice and the autumnal equinox.

Thus, the Mayan system of astronomy was, in a manner, the reverse of that used by modern astronomers. Instead of gazing at the heavenly bodies, they let the sun and stars "look" at them. The knowledge gained in this manner was used by the priest-scientists to inform the rural population of the proper seasons at which to plow, sow, reap and perform other agrarian duties.

The astronomical observatory was an improvement over an earlier method in which the summer solstice and equinoxes were determined by sighting from a temple past monuments at the sun. The Mayas were undoubtedly the best astronomers of ancient times.

IN the realm of mathematics the Mayas, too, were vastly superior to all of their contemporaries. They invented the idea of zero 1,000 years before it was conceived by the Hindus, who passed it on to the Arabs and, through them, to the Europeans.

The Mayas were intensely religious. Like the Romans, they had a pantheon of many gods, a priesthood and a sisterhood the members of which were pledged to celibacy, and the institution of the confession of sins. Peace-loving and apparently extremely trusting, none of their magnificent cities was fortified.

The Spaniards who, in the beginning of the sixteenth century, "discovered" the strange Mayan country and its people, were also religious in the extreme. Unfortunately their priests, in their excessive zeal to stamp out the Mayan "works of the devil," destroyed most of their wonderful ancient lore.

Only three books survive the bonfires of the old Spanish padres. From these and from the Mayas' intricate inscriptions, science patiently has pieced together a story as fascinating and romantic as any which the history of the human race affords.

But several chapters of this beautiful story are missing. Perhaps Colonel Lindbergh's discoveries and the find of the Mexican archeologists will provide the world with the solution of the mystery of the Mayas' origin and tragic passing.

The World Must Outlaw Noise

(Continued from page 19)

vide too much stimulation. Some observers already see this over-stimulation in what they deem over-nervous America.

Another effect of noise, of psychological importance, is the exceptional annoyance caused to most people by a few specific kinds of racket, like the sound of scraping a steel shovel over a cement floor or the shrill squeak of a lead pencil drawn across a plate glass window. If the numbers of complaining letters is a fair criterion, the common city noise which comes nearest to belonging in this especially annoying class is that of riveting on steel buildings.

HEALTH officers and others confronted with the problem of city noise must first consider which noises chiefly annoy their citizens and which can be most easily suppressed. Better service for automobile trucks undoubtedly would most greatly reduce noise everywhere, but regulations requiring this might be difficult to enforce.

Some other very annoying noise makers, however, can be suppressed by any city without fear of serious protest. One is the loudspeaker playing on the street, as an advertisement for radio and music stores.

Again, any city can discourage the enthusiasm of firemen who work the sirens of fire engines responding to calls at night. There is no possible reason why this warning should be heard more than a few hundred feet away from the engine's proposed path, but firemen get vociferous and let their nighttime tooting spread for miles.

RIVETING machines may be replaced some day by welding, but there are still grave technical and legal difficulties about this change, and antiriveting regulations seem premature. The noises let loose by midnight handlers of ash cans are instances, of course, of inconsiderate carelessness, already prohibited by the nuisance ordinances of most cities and requiring merely better inspection or the attention of citizens to be enforced. The cowbells of the junk wagon and the screeching horn of the fish peddler are noises which have long outlived their usefulness and no longer have a rightful place in the modern city.

A noise which I believe to be altogether useless and easily eliminated is that of the automobile horn. There is no reason why the blowing of an automobile horn in a city, except in emergency, should not be made a misdemeanor punishable by jail, just as most cities now punish the promiscuous shooting off of firearms on the streets. An actual census of automobile toots on a typical New York City street corner a few weeks ago showed that less than three percent of them were necessary. The other ninety-seven percent were useless and ill-mannered shouts to someone else to get out of the tooter's way. If civilized pedestrians shouted insults at each other when they met or passed on the sidewalk in the same mental attitude in which the average automobile driver toots his horn, the daily American average of black eyes and punched noses would show a startling increase.

Whatever the psychological experimenters ultimately decide that noise is doing to civilization, there is no doubt that it is annoying millions of citizens. When these citizens get mad enough, excessive city noise will be stopped by the force of public opinion. The modern, busy city is never likely to be as quiet as a country village; nor might that be wise. But cities less noisy than the present, providing for their citizens a safe dose of one noise cocktail before bedtime instead of a whole bottle full of them, are possibilities as soon as enough of their citizens want them.

Home Movies—1930 Family Album

(Continued from page 27)

slowly through a projection machine while he has explained to the players the good and bad points in their form. In connection with football, the small cameras have also been used by scouts to study the plays of teams to be met later in the season.

In fact, athletics has proved a fertile field for the use of the home cinema. Babe Ruth in baseball, Bill Tilden in tennis, Bobby Jones in golf, and Gene Tunney in boxing, all are said to have studied home movies of themselves to improve their form. When Charley Paddock, world record sprinter, went to his first Olympic Games, sports writers predicted he would carry everything before him if he could develop a quicker start. In the first four or five strides, he lost time. His coaches were unable to put their fingers on the difficulty. The split-second getaway was too swift for them to see the trouble. When moving pictures were made of the start and run at slow speed through the projector, they revealed that, instead of bringing the rear foot straight ahead, in getting out of the starting holes, Paddock was bringing it around in a semicircle. When this was remedied, he began breaking records in quick succession.

AT THE University of Illinois, Prof. Coleman R. Griffith, Director of Research in Athletics, has found his home movie camera an aid in studying fear and awkwardness in tumblers and acrobats. When the pictures are thrown upon a screen in slow motion, he can detect the exact points where fear or awkwardness marred an otherwise perfect performance.

The cost of making home movies is still one of the drawbacks for the average man. Cameras cost from $80 to $400 and projectors are as expensive as a medium-priced camera. The film costs $6 for a 100-foot roll, including development.

A recent innovation which promises a radical cut in costs is a camera that takes four times the usual number of pictures on standard-sized film. An ingenious mechanism in the camera moves the film alternately sidewise and lengthwise in regular order. The illustration at the bottom of page 27 shows the sequence in which the pictures are taken. The new camera operates at the standard speed of sixteen pictures per second, and since it takes four times as many pictures on the same length of film as does the standard camera, a 100-foot reel lasts four times as long; in other words, it will take four times as long a picture. This is equivalent to cutting the cost of film to one fourth or from $6 to $1.50 for equivalent motion picture photography. This economy also reduces by one fourth the amount of film that must be carried on a given trip, both in weight and bulk.

GEORGE EASTMAN, father of amateur photography and amateur cinema-photography, made a prophecy in POPULAR SCIENCE MONTHLY, a few years ago (P.S.M., Jan. '25, p. 141). "Our first Kodak," he said, "sold for twenty-five dollars. Now, one for one tenth that amount gives larger and better pictures than those first amateur cameras. It is not unreasonable to assume that home movies will go through a somewhat similar development; that in a few years, you can project motion pictures on the walls of your home for very little more than it costs you now to place a still picture in your album or to have one framed."

While the cost has not yet been materially reduced, the design of cameras and projectors has steadily improved. The cameras have become more compact, easier to carry and simpler to use. Home movies in color form one of the latest steps (P.S.M., Oct. '28, p. 17). A compact device, fitting over the lens of the camera, enables the photographer to catch the tints and shades of objects and backgrounds, adding to the reality of the pictures on the screen.

Among the interesting bypaths open to the amateur movie maker is the taking of trick reels. Two of the easiest are known as "Riding the Pilot" and "Reverse Action." In the first, the track behind a fast train is photographed from the rear platform with the camera upside down. Reversed, on the screen, it appears to have been made from the cowcatcher of a speeding locomotive. By use of "reverse action" a diver, for example, can be shown flying feet first back out of the water up to the diving board from whence he started. In making such a shot, the camera again is held upside down. When projected the film is turned end for end. This reverses the action of the subject but keeps it upright on the screen.

THE shutters of many cameras now available operate at several speeds. The usual sixteen pictures a second can be taken in normal light; eight pictures a second, with consequent longer exposures, in poor light; and high speed pictures, at sixty-four a second, can be made for producing the so-called "slow" movie. With a modern camera, an amateur can often capture night scenes without special lighting. Recently, A. C. Hayden, a manufacturer of Brockton, Mass., carried his home movie camera on a trip to New York City and obtained excellent reels of Times Square by the light from the advertising and theater signs of the "Great White Way."

Other interesting night reels have been made of fireworks and of searchlights playing on the sky. When the ground is covered with snow, a street corner, even in a small town, is sufficiently lighted by an arc lamp for obtaining interesting silhouette effects. In making a movie of a snowstorm in the open, the camera should always be protected by an umbrella so the flakes will not fall too near the lens and obscure the picture. This protection also keeps flakes from falling directly on the lens, causing a total loss of the scene being filmed.

Already, slightly more than five years after the first home movie outfit appeared on the market, more people own cameras than possessed automobiles in the United States six years before the World War. With lowered costs and improved apparatus, the uses of the cameras will increase. The fun and usefulness of the home movies has just begun.

Chinese Enjoyed "Talkies" 2,000 Years Ago

THE ancient Chinese, credited with the invention of the earliest printing press, paper and gunpowder, also enjoyed a primitive form of "talkies" more than 2,000 years ago. Investigators of the Field Museum of Natural History in Chicago have found that the shadow play, really a forerunner of the American conversational movies, which is still popular in China, was first mentioned in historical documents dating from 121 B.C.

A type of two-dimensional marionette, cleverly cut from transparent parchment and provided with movable head, arms and legs, is used in the shadow play. The flat, acting figures are manipulated back of a white gauze screen lighted from behind by oil lamps, while a reader recites the lines of the various characters and a small orchestra plays appropriate music. This form of entertainment is more popular with the great masses of the Chinese people than the real drama, first because the reader uses the vernacular instead of the literary, language of the stage and, secondly, the shadow play is produced with scenic effects.

Pneumatic Stevedores Heave Coal and Wheat

(Continued from page 52)

New York post offices. One line even crosses the Brooklyn Bridge over the East River to collect mail from Brooklyn. These lines, comprising twenty-seven miles of two-way tubes, handle ten million letters in a day. A network of 150 miles of leased telephone wire is used in dispatching these carriers and supervising their movement from a central station.

A sudden increase over the five-pound air pressure used, or a blunder in dispatching a tube over the wrong line, might send a death-dealing projectile running wild. A mail carrier weighs thirty pounds with its load of 500 or 600 letters. Such a projectile, bursting from a tube at high speed, could kill a man easily. Therefore safety air cushions slow its speed from thirty miles to one mile an hour before it rolls out upon the receiving trough at its destination.

AT ELEVEN o'clock at night, the checking operation of "clearing the line" is performed by telephone from the central control office. An operator, over leased wires, calls the most remote stations in turn and orders each to dispatch a specially-marked "last carrier." Its passage is reported in turn by the stations along the line, and as each section of the line is "cleared," the power on that section is shut off and the operators go home. At last the final tube link is pronounced clear, the central operator receives the official "Good Night," and the great system is shut down until the following morning.

Although these tubes were designed solely to carry mail, odd parcels occasionally have strayed into them. The story is told that in the early days of the tube service the employees of one New York station shot an envelope containing money through the tube to another post office in the chain—and in return a half dozen ham and bean sandwiches from a restaurant came flying back through the tube. Even a live rabbit was "mailed" through one of the tubes not long ago to demonstrate the smoothness of their operation. The animal emerged unharmed. Similarly, a sick cat once was rushed by its owner to a cat hospital via the pneumatic system—but postal employees say that the cat leaped from the opened container with a speed approaching that of the tube carriers themselves and only with great difficulty was captured and sent on its way.

A WAR story concerning the underground tubes has just been revealed. One day in 1918, just before the Armistice, a group of Government officials and British engineers asked the company that operates the New York tubes whether it would be possible to devise a pneumatic tube system to carry food and ammunition to front-line troops under shell fire. The plan was to have a line ending at the front in an open trench and to shoot high-speed carriers through it. Extra sections of camouflaged pipe would be added when the troops advanced, or removed when they retreated. There would be no return tube, and the carriers would be carted back as best they might.

Demonstrations were made on a New York pneumatic line which the firm had built for the Government, and which today carries jewelry and papers for a mile between the United States Customs House and the Appraiser's Office. The tests showed that such a system would need a trench long enough to let the containers fly as far as fifty feet when they emerged from the open end of the tube. Before such a system could be developed, the Armistice was signed and all the company's records ordered destroyed.

But it was not necessary for pneumatic tubes to be used in the (Continued on page 132)

Pneumatic Stevedores Heave Coal and Wheat

(*Continued from page 131*)

war for Europe to become familiar with them. In fact, the first practical system of pneumatic transmission was installed in London as long ago as 1854, where it was used to connect the main telegraph office and the Stock Exchange. By 1872 Berlin had a city mail system of pneumatic tubes. Paris followed with the pneumatic mail post which is familiar to tourists today in a unique form of special delivery service, in which messages on special forms bearing extra postage and dropped in "pneumatique" mail boxes are delivered with such celerity that they are used as frequently as the telephone for making immediate appointments. In 1892 the first American mail system was installed in Philadelphia.

UNDER ordinary conditions pneumatic tube carriers are practical up to about eight, or possibly ten, inches in diameter. Where larger carriers are required electric systems are more economical. But early experimenters did not recognize these limitations, and as early as 1864 a suction line was constructed for mail in London in which miniature railway cars filled with mail were sucked through a tunnel four feet in diameter. The system proved too slow to carry mail in bulk. Again in 1867, a New York engineer built a unique subway in which he used compressed air to propel a ten-passenger car for a distance of about 200 feet. This system was operated for a short time as a novelty.

Today the practical applications of pneumatic tubes have far outrun the original dreams of their designers. New ones are ahead. Pneumatic tubes have been proposed to speed mail from outlying airports to cities. Banks and financial firms are interested in their possible use to avoid the necessity of sending messenger boys with valuable securities through the streets—for no one can "hold up" an underground conveyor. The "mechanical messenger" may have undreamed-of applications tomorrow.

Here Are Correct Answers to Questions on Page 49

1. There is no one "best" type of heating system. Each has peculiarities that make it suitable for use where these peculiarities are advantageous. Hot water heat, for example, is excellent where uniform temperature with the minimum of attention to drafts and so on is required. Hot air gives heat in the shortest possible time after the fire is started but is not suitable for low, rambling buildings. Steam is cheaper to install than hot water, gives much quicker heat, but requires more attention to drafts unless automatically regulated. Vacuum vapor costs more to install than steam and gives more even heat. Steam, vacuum vapor, and hot water can be installed in any type of house. Hot air works well only in a house that is compact, with a floor plan approximately square.

2. By means of an electrically driven conveyor screw, the mechanical stoker forces the fresh coal up through the bottom of the fire. The incoming fuel pushes the ashes out over the edge of the grate, where they fall into the path of another conveyor screw that dumps them into a container outside the furnace. The method of burning, combined with a forced draft, permits the use of the smaller and less expensive sizes of coal.

3. Long, low radiators heat more efficiently than short, high ones.

4. It is entirely practical to heat a home by electricity if the (*Continued on page 133*)

Here Are Correct Answers to Questions on Page 49

(Continued from page 132)

problem is considered solely from an engineering standpoint. The present cost of electric current, however, makes the cost prohibitive. Heating by electricity is the ideal method when judged from any angle except that of expense. In years to come, when the problems of the generation and distribution of electricity have been solved, undoubtedly electric heating will replace all other methods now in use.

5. Relatively large pipe is used on the one-pipe steam system and the piping is so installed that it is downhill all the way from each radiator to the boiler. Steam flows continuously through the upper portion of the pipe to the radiator, condenses, giving its heat to the walls of the radiator; then flows back to the boiler by way of the lower portion of the pipe. The single pipe therefore serves to carry both the steam supply and the water return. The valves on the radiators of a one-pipe system must be either all open or tightly closed, or there will be a hammering noise caused by the alternate flowing of water and steam through an opening not large enough to allow both to flow at the same time.

6. Assuming that the construction of the houses is approximately equal as to heat insulation, weather-stripping, and so on, the trouble may be insufficient radiator surface, too small a boiler, an inefficient boiler, or unskillful handling of the furnace fire. Installing more or larger radiators will remedy the first trouble, putting in a larger boiler will remedy the second, adding sections to the boiler will remedy the third, and learning how to take care of a furnace fire will remedy the last. If the house itself is poorly built, much can be done by adding heat insulation in the walls and roof, weather-stripping the doors and windows, and so on.

7. The shape of a boiler is of no particular importance. What counts is the amount of surface that is exposed to the radiant heat of the fire and comes in contact with the flames and hot gases. Few boilers made today for home heating are as efficient as they would be if home owners were willing to spend more for them. The finest boiler obtainable always results in a net saving over a period of years.

8. If smoke and gas come out of the hot air registers of a hot air heating system, there is a break somewhere that permits the gaseous products of combustion to get into the air heating chamber. This is a serious matter, because of the danger of coal gas poisoning. The heating plant should be shut down at once and the trouble remedied.

9. Coal, as it comes from the mine, is in lumps of all sizes. It is run through a crusher and then over sieves with holes of different sizes. The large lumps are broken into pieces of all sizes. It is impossible to break a large lump into pieces of a predetermined size. Anthracite coal of the so-called stove size is most in demand for domestic use, and as only a certain proportion of the total amount of coal mined can be classified as stove size, the demand forces a higher price.

10. Except in extremely cold weather it is desirable to bank the fire at night if you have a steam, vacuum vapor, or hot air system. In zero weather the fire should not be banked because the house gets so cold that it would take quite a time to heat it in the morning. With a hot water heating system it is not desirable to bank the fire at night.

Keeping Pace with Aviation

(Continued from page 42)

spring is proposed for the future program of the *DO-X* plane. Two sister ships of equal size are under construction for the Italian government at the Friedrichshafen, Germany, plant. Similar or even larger ships will be built in the United States, according to the recent announcement of the American automobile concern which will back their construction here under the Dornier patents.

Experts suggest that such huge flying boats may seriously compete with dirigibles for large-scale transport. They point out that while dirigibles have a slightly greater cruising range and more comfort, an airplane of the *DO-X's* size has the advantage in greater speed and in the smaller crew required to run it.

Planes Hunt Bacteria

AN AIRPLANE hunt for bacteria was a recent novelty at Cambridge, England. Its object was to determine how plant and crop diseases are spread in upper air currents.

Several kinds of germ traps were used by the airplane that made the tests. Glass slides smeared with petrolatum, and test tubes and glass dishes filled with jellies offering breeding places for germs, were exposed at certain times during the flights, which reached a maximum altitude of 13,000 feet.

The tests showed that large numbers of bacteria and fungus spores were present and vigorously alive as far as two miles above the earth. They seemed especially to congregate upon clouds. Although the tests were not concerned with disease germs of a sort that attack man, they showed that these, too, probably are carried by wind currents at great heights above the earth and that epidemics may spread in this way.

Tailless "Flivver" Plane

V-SHAPED wings and the absence of any tail whatever are novelties combined in the latest German plane tested recently at Berlin. It demonstrates, as did the "windmill" autogiro plane, that radical ideas may still have a place in airplane design.

The tailless machine is shaped like an arrow, with the pilot's cockpit in a stubby fuselage. A motor of only eight horsepower drives it at a speed as high as seventy-eight miles an hour. In landing, vertical rudders serve as brakes. On the take-off the plane is launched by a catapult, needing a run of only a few feet.

Especially significant is the fact that the "stork," as the new plane is called, can be sold at a lower price than many automobiles—about $800. This and the reported ease of piloting suggest its possible development as a new type of "flivver" plane for private use.

Repairs on the Fly

BOARDING a flying plane by a sixty-five-foot rope ladder and leaving via parachute was the unusual performance of Dale Dryer, airplane mechanic, when an endurance plane over Buffalo, N. Y., sent a call for repairs.

Heavy weather had damaged the stabilizer of the airplane, which had been aloft more than 190 hours. First a rope ladder was passed from another plane to the endurance craft, whose crew attached it to the under part of the fuselage. Then Dryer went aloft in a relief machine, flew beneath, and caught the ladder on the third attempt. He scrambled up it, while the relief plane dived to keep out of the way. The repair was soon completed, and Dryer left by parachute.

The feat was all the more remarkable because it was entirely without previous arrangement. Despite the daring stunt, the endurance plane was forced down a short time later when it was damaged again in refueling.

Back of the Month's News

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very light. Nickel, tantalum, and other metals are good resistors of corrosion. What Dr. Jeffries hopes for is to find one metal with all of these characteristics or with most of them.

Probably the future universal metal, competent for nearly all metallic uses, will be an alloy. The properties of the pure metallic elements are apt to be unchangeable. Mixtures and alloys mean possibilities of useful alteration. In the aluminum alloy duralumin, the metal now so largely used for aircraft, small additions of copper and other metals make the aluminum, which in its pure state is quite soft, as hard and strong as many kinds of steel. The lightness of the aluminum is retained.

Sun Spots and Life

ANY amateur scientist desirous of testing for himself the effects of sun spots on tree growth, on human wars, or on anything else, down to the rate at which a farmer's hens lay eggs, now has conveniently at hand the material for such studies.

Curves of the sun spot variation from year to year, indicating the familiar cycle of 11.5 years which sun spots are supposed to display, have been prepared by many investigators on the basis of many different kinds of measurements. Recently, Professor Luigi Taffara, distinguished astronomer of the Royal Astrophysical observatory at the University of Catania, Sicily, carefully studied all available records of sun spots and solar activity and combined these into a single curve. Undoubtedly this curve constitutes the most complete and accurate record of the sun's variation yet available anywhere.

Sun spot studies have had their ups and downs in scientific history. When sun spots were first observed by Chinese sages centuries ago, they were deemed to be omens of exceptional importance. For hundreds of years this magical aspect predominated. Finally, modern scientists discovered that a sun spot is merely a storm in the solar atmosphere and insisted, it now seems too dogmatically, that no sun spot could affect happenings on earth.

Proof accumulates, however, that the solar changes indicated by sun spots do affect earthly things. The 11.5-year cycle has been traced unmistakably in weather records, in the levels of African lakes, and in the annual flow of the Nile. Professor A. E. Douglass, of the University of Arizona, finds sun spot influences in the annual growth rings of trees. Records of Hudson's Bay Company show sun spot influences on the number of fur bearing animals and the annual catch of furs. Danger from icebergs in the North Atlantic discloses the same 11.5-year curve. Such records are now far too numerous to be explained away. All of them go back, experts agree, to influences of the sun spot cycle on weather. When there are many sun spots the sun's heat is slightly greater and the ultra-violet radiation in sunlight is also greater. These changes affect weather and living matter in ways not yet fully understood.

Two years ago Russian scientists suggested relations between the sun spot cycle and human events like riots, revolutions, and wars. Using Professor Taffara's curve, any person who feels like doing so may now collect data of the price of stocks, the occurrence of crimes, the volume of business sales, or anything else, back to the beginning of accurate solar records in 1878, and may then compare these records with the conditions of the sun.

As Professor Taffara's curve discloses, the cycle is not a precise one of 11.5 years. Perhaps the previous failure to find clear sun spot influences in historical matters has been due to search being made for this precise cycle, rather than for the more complicated ups and downs which the actual curve discloses.

How I Got into the Air

(*Continued from page 30*)

unable to speak English. Then the fun began.

For two days, I ate nothing. On the third morning I was watching a girl flip pancakes in a restaurant window on Broadway. A truckload of oranges stopped across the street. The driver began to carry the crates into a cellar. I went across, grabbed a crate and followed him. For two hours I carried oranges without saying a word—because I didn't know any to say. When the truck was empty, the driver handed me seventy-five cents. It looked like a million dollars. But it all went for one meal.

The next morning it snowed. I saw men shoveling snow into trucks in the streets. One was a dignified gentleman wearing patent leather shoes. I thought: He doesn't belong here. Neither do I. But, here we are. I got a shovel and lined up beside him. At the end of three days, I had earned fifteen dollars. Then I remembered that some people who had met me at an expensive hotel had invited me to a Christmas eve party. So I put on my Tuxedo, which hadn't been pawned yet, and with the fifteen dollars I had earned shoveling snow in my pocket, started for one of the most fashionable hotels in town. When I came home, the fifteen dollars was gone.

BEFORE I climbed into a cockpit again, I held nineteen different jobs. My plan was to learn enough English to land a place as draftsman in an aircraft factory. So every morning I bought a newspaper and studied it and each day I took twenty little cards to work with me. Each had a word written on it. When I learned the word, I transferred the card to another pocket. After the first few days in each place the boss would catch me shuffling the cards in my little game of solitaire and I would be bounced out to look for another job.

For one week, I worked in a boiler factory. Another time, I found myself walking narrow steel beams twenty stories up in the air. I had convinced the boss that putting up skyscraper skeletons was my lifelong game. But being an aviator didn't help up there. I got so dizzy that I almost fell off my narrow perch. And I wasn't wearing a parachute, either.

At last I landed a job with an aircraft company. But there wasn't any flying connected with it. All day long, I swung a file smoothing little metal fittings.

About this time, I met a fellow who had bought an old Army L. W. F. biplane. It was so heavy that the boys at Curtiss Field called it "The Streamlined Brick." It had been sitting out in the weather for months and was ripe for a crash. One day the owner broke his arm cranking the propeller. He let me fly the crate while he was recovering. It was while I was up in this flying brickbat that I almost ruined the business of the Curtiss Flying Service, single-handed.

I was coming in over the same gully where Fonck crashed in his transatlantic attempt in 1926, when a control wire snapped. We came down in a hundred-foot swan dive, right in the middle of the field. "Casey" Jones was running the Curtiss Flying Service (which now controls nearly forty flying fields), on a shoestring at the time. The bread and butter of the flying service came from week-end passengers. And here I came down in a big splash right in the middle of the field before the Sunday crowd and scared everybody away.

As soon as I mastered English, I began writing to flying schools, trying to land a place as instructor. My letters apparently were thrown in the wastebasket. I began going around in person. I was too big to throw in the wastebasket. Finally, I got a chance to try out with the Curtiss school. I made the most of it. Sometimes I flew forty to forty-five hours a week.

But I was happy. I could fly all I wanted and I was dealing with youngsters as crazy to fly as I had been.

The average young person today will have an easier time breaking into flying than I did. Schools are numerous; instruction better; openings more frequent. If I were starting all over again and had little money, I believe I would follow some such plan as this: Save enough to take a ten-hour course. That costs $300. A twenty-five-hour course costs $600. If you can afford that, so much the better. The ten-hour course will get you to the point where you can solo. But you have a lot to learn. It takes fifty hours in the air to get a limited commercial license, allowing you to carry passengers, and 200 hours to get a transport license. Piling up flying time is costly. Renting a ship costs between twenty and twenty-five dollars an hour. But if you can pick up enough knowledge about caring for planes, and land a job at or near an airport, you can usually find a pilot who will take you up and let you get in a little time on the side in return for helping him care for his ship.

In a year or two you will have your fifty hours and will be ready to land a job hopping passengers at some small airport, or working as a relief pilot on a transport plane. In this way you can get in your 200 hours and your Transport License. After you get that, it is from door to door for you, until you get a try-out. Getting into the air still takes determination to stick like a postage stamp.

A second plan is to get into the Army flying service to pile up hours. Transport companies are looking for young pilots who have graduated from the Army's advanced training school at Kelly Field.

One of the problems of breaking into aviation is picking a flying school. A simple rule is to pick a school that uses high-priced training ships. Such a school will not trust its costly equipment to incompetent instructors. It will not allow students, flying without breakage charges, to go up before they are fit to solo. The Department of Commerce is now licensing schools. A letter to the Aeronautics Branch at Washington will let you know the best ones in your territory.

SOME funny things happen at flying schools. Once, a student got his throttle jammed open in the air. He flew around for two and a half hours trying to think how to get down. Then he thought of cutting the switch and landing with a dead stick. Another time a girl student got lost in the air. She couldn't find the landing field. She started out to look all over Long Island, and she had been right over the field all the time.

The three commonest mistakes a beginner in flying makes are climbing too rapidly on the take-off, skidding on the turns, and leveling off too soon in landing. Once I had a student who made a perfect landing—thirty feet up in the air. He washed out the landing gear, but it cured him of ground-shyness. Another student wasn't ground-shy enough. He came down in a steep glide and hit the ground going seventy miles an hour. He bounced higher than the hangars. But that boy had nerve. He circled the field again and came down on three points.

Last week, a middle-aged man came to the school and said he wanted to learn to fly. He explained that he ran a steam shovel. The day before, he had seen a monoplane sail past against a cloud-filled sky. His back was aching at the time and he said to himself: "Me for a soft job like that."

A lot of people have the same idea—that flying is a snap. In truth, it is hard, nerve-straining work. But once you have been bitten by the flying bug, nothing else will satisfy.

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What Science Achieved in 1929

(Continued from page 21)

pany. This gives only the intensity of sunlight and may therefore be used as a home light.

The use of toxic gases in industry aroused the consternation of the public when deaths were found to be due to methyl chloride leaking from certain types of home refrigerators. Means were developed for adding an odorous gas to methyl chloride so that the householder might realize its presence.

Experimentation with cancer in hundreds of laboratories has yielded results of interest, but it is still safe to say that no specific method for the prevention and treatment of cancer has been discovered. The speed of modern life is reflecting itself in a decrease of expectancy of life after forty years of age.

The liver is found to be a vast storehouse of remedies, most conspicuous at this time being the extract used for the specific control of pernicious anemia. Workers in the field of genetics have discovered the specific hormones to control the determination of sex and maturity. Control of the metabolic rate of the egg permits the development of male or female as the experimenter may desire. A skin test for pregnancy is being perfected.

An electrical device for sealing blood vessels permits safer and more rapid operations on the brain. A new method of staining the germ of tuberculosis received a medal of award because it permits the more certain diagnosis of this disease.

The big problem of modern medicine is to furnish scientific medical diagnosis and treatment to all people at a price they can pay.

ASTRONOMY

HEBER D. CURTIS

Director, Allegheny Observatory

NEARLY all the research of our great modern observatories is in the form of vast "continuing programs," planned to last decades instead of months. So numerous have been minor but none-the-less valuable accretions to the total of astronomical knowledge during 1929, that it is difficult to select any particular one as epoch-making. In one field it may be the finding of a brother Milky Way moving over 2,000 miles per second; in another, the investigation of some maverick star, the sending stations of whose atoms seem to follow no regular law of broadcasting their spectra; in another, the proof that hitherto unexplained spectral lines are due merely to some familiar element under strange and unusual conditions of excitation; in still another field, the laborious calculations which will enable us to predict the vagrant paths of some group of minor planets for a millenium to come.

It is sufficient, for the astronomer at least, to know that more than satisfactory progress continues to be made in the long and laborious research programs of the world's large observatories.

Perhaps most popular interest continues to center in the project for a great reflecting telescope of 200 inches aperture. This must still remain as a hope

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What Science Achieved in 1929

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for the future, as ten years may prove to be too short a time for its completion. Much preliminary research must be done before we shall even be certain that a 200-inch mirror, weighing thirty tons, is a possibility. But encouraging results have already been secured as to the possibility of making such a mirror of fused quartz. The year 1929 has been marked by progress in such preliminary experimentation, and in the details of the design of this giant instrument, which may be expected to display an outer universe at least fourfold and perhaps eightfold as great as at present.

ARCHEOLOGY

NEIL M. JUDD

Curator of American Archeology, United States National Museum

WITHIN the Americas, the most notable achievement unquestionably has been the National Geographic Society's establishment of a chronology that adds some 1,500 years to history; determines the age of Pueblo Bonito, most famous ruin of the southwestern United States; and dates some forty other villages heretofore indefinitely classified as prehistoric. Henceforth it will be possible, by correlation, more closely to approximate the relative ages of divers New World peoples whose dead civilizations are gradually being revivified by various research institutions.

From Europe and Asia come echoes of new discoveries by the Pennsylvania-British Museum expedition at Ur of the Chaldees, by the British Academy in Constantine's Hippodrome at Constantinople, by Italians throughout Italy and in Crete, by French archeologists at Delos and Delphi, by Russians in the Crimea, and by Americans at Corinth and elsewhere.

PHOTOGRAPHY

C. E. KENNETH MEES, D.Sc.

Director, Research Laboratory, Eastman Kodak Company

AMONG the scientific applications of photography, there should be noted a considerable advance in the photography of the infra-red spectrum. This has been made possible by the application of Neocyanine plates. Such plates have been used for photographing the infra-red end of the solar spectrum and were also employed at the Sumatra eclipse with good results.

F. F. Lucas of (Continued on page 140)

What Science Achieved in 1929

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the Bell Telephone Laboratories has made great progress in the use of ultra-violet light in microscopy. This work was originally done in connection with metallography, but he has now applied his methods to biological photographs and has obtained most interesting and valuable results, especially in the photography of tumors.

Amateur cinematography continues to develop. A color process which was introduced in 1928 is finding a wider extension in this field.

In standard motion picture work, there has been a great development of sound photography, and the "talkies" are now universal.

A sensation of 1929 has been the introduction of wide film by means of which a large picture of much greater width is being shown. It is expected that this wide film will have a great future in the industry.

Color motion pictures have been introduced on a large scale during 1929, and a considerable portion of the pictures shown are now in color. Preparations are being made throughout the industry to extend the use of color, as well as of wide film and of sound.

GEOLOGY

ALFRED C. LANE
Professor of Geology and Mineralogy, Tufts College

PERHAPS the great achievement of 1929 is the enlistment of more precise physical and chemical methods to help in unraveling the history of the earth and its structure. For instance, by studying its electric conductivity, more conductive strata have been located perhaps thirty miles down.

Again, the records of the relatively new station for the reception of earthquake waves at Honolulu have identified two or three different layers of rock. Adams and his colleagues of the Geophysical Laboratory have been testing the properties of rocks so that we can tell the velocities with which granites, basalts, etc., propagate such waves, and thus identify the rocks.

Delicate tests of gravitative force have been carried on not only at sea, showing that the sea floor is heavier than the continental rocks, but also in the search for oil. Wells for oil have been carried deeper with startling rapidity. Only a short time ago the deepest well in the United States was 7,756 feet. Now Texas and California are racing with a number of wells over 8,000 and up to 8,600 feet deep.

The age of the upper Cambrian trilobite-bearing shales of Sweden has been estimated by the amount of helium and lead produced from the uranium they contain. Arthur Holmes has estimated the age of two igneous rocks from the ratio of the helium produced. It seems to me that we may look forward to an approximate dating of geologic strata by the helium ratio within ten years, and that we may look as an ultimate goal to a year-by-year, climatic history of the earth comparable to that

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What Science Achieved in 1929

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which Huntington has worked out from the rings of the California great trees for the last three thousand years. Only this will go back more than three hundred thousand thousand!

ANTHROPOLOGY

CLARK WISSLER, PH.D.

Curator of Anthropology, American Museum of Natural History

A REVIEW of anthropology reveals an increase in the number of institutions and endowments supporting the study of prehistoric man and the contemporary less civilized races, accompanied by a corresponding gain in the number of investigators. Almost every part of the land surface of the world is under observation. National governments are giving more attention to the preservation of antiquities and to recording the customs and arts of their subject races. The year has not been a period of new discoveries, but has been characterized by steady progress in following the leads offered by those of recent years and the testing of previous observations.

As usual the time of man's first appearance in America is a major interest, and new evidence has come bearing upon his presence here in late Pleistocene times. There are now four places in the United States where stone implements have been found in apparent Pleistocene association, so we can say that this year marks the advancement of the American Pleistocene man problem to its final stage. Definite conclusions may be expected at any moment. In Europe, Africa, and the Near East the data for the early Stone Age cultures have been enriched.

Respecting the study of existing races mention should be made of progress in the exploration of New Guinea and investigations of the remaining few tribes in Australia and Melanesia living in a near-primitive state.

METEOROLOGY

CHARLES FITZHUGH TALMAN

Librarian, U. S. Weather Bureau

THE aviator now is getting weather information along the principal commercial flight-ways of the world. As the information is supplied by radio broadcasts, it is available to the entire community, and it is found to have many useful applications

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A definite program for getting ahead financially will be found on page four of this issue.

What Science Achieved in 1929

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altogether outside the domain of aeronautics.

Since July 1, 1929, we have had in the United States a service of radio weather bulletins and forecasts every three hours, day and night, covering a belt 400 miles wide extending from coast to coast along the Transcontinental Airway. Though established for the benefit of aviators, it is of such general utility that the great cost of maintaining it would probably be justified even if there were no such thing as aviation. Hence the inauguration of this new service, which foreshadows similar arrangements for the whole country and marks a milestone in the history of practical meteorology.

The British have begun broadcasting weather maps and facsimile weather bulletins by radio, using the Fultograph process. A new French sounding balloon sends out automatic reports by radio of the temperatures and barometric pressures encountered throughout its flights. The nations of the world have agreed upon a plan of securing regular and uniform radio weather reports from a total of 1,000 selected ships upon the high seas.

MINING AND METALLURGY

SCOTT TURNER, E.M.
Director, U. S. Bureau of Mines

ONE interesting development in the mining field in 1929 has been the steady advance in prospecting methods, by which many valuable mineral deposits heretofore unknown have been discovered.

Remarkable increases in efficiency are reported at various mines developing large low-grade ore bodies. This has been achieved by the application of the caving method of mining and by thorough underground organization. By changing from the usual advancing method to the retreating method, in Michigan copper mines several thousands of feet deep, the former menace of crushing from heavy rock pressure has been removed. At other mines in Michigan, Tennessee, and Canada, ore extraction is started at the lowest levels, the work progressing from the bottom up. This system eliminates prohibitive pressures, saves timber, disposes easily of waste from developments, and gives less inflow of surface waters and greater safety.

Improvements in mine ventilation have added greatly to labor efficiency.

The most important developments in ferrous metallurgy have been the Ashton process for producing wrought iron in large tonnages at low cost, the tremendous increase in the production of stainless steels and irons, the introduction of nitrided steel, and the introduction of tungsten carbide as a machine tool. In nonferrous metallurgy, the advances to be noted include a willingness on the part of industry to invest money to effect small savings in metal recovery and the development of lighter and stronger alloys for aircraft.

In the ore-dressing field, there have been steady developments in flotation and classification, resulting in improved grade of product, thus giving richer feed to smelters which were consequently able to produce more metal per unit of slag and impurities. The flotation of nonmetallic and nonsulphide ores has increased greatly. In secondary crushing, cone crushers are gradually replacing rolls and small gyratory breakers.

PSYCHOLOGY

A. T. POFFENBERGER, PH.D.
Professor of Psychology, Columbia University

THE outstanding event in the psychological world during 1929 was the ninth International Congress of Psychology, held for the first time in America, at Yale University, September 1 to 7. Twenty-one foreign countries were represented by from one to twenty-two psychologists. There was a total attendance of more than 1,000, the largest group of psychologists ever brought together.

Of particular interest were the reports of the ten representatives from the Union of Socialistic Soviet Republics. Their extreme centralization of education, business, and industry offers particularly favorable ground for applying psychology on a grand scale. As an indirect result of the congress, plans have been made for making this work as well as that of other countries more generally accessible, through translations and otherwise.

Particularly significant is the publication by the Clark University Press (Worcester, Mass.) of the Psychological Register, containing the names of contemporary psychologists throughout the world, together with a bibliography of the publications of each individual.

The formal announcement of the Institute of Human Relations at Yale University marks a new era in the study of human problems. Its aim is to study man in his social setting, and it will bring together all the sciences which can aid in this undertaking, including—in addition to psychology—sociology, anthropology, law, medicine, and others. Many problems hitherto too complex for solution by any one scientific group should respond to this joint attack.

Lighted Arrows Tried as Signals for Liners

THE Royal Dutch liner *Batavier V*, carrying on her bridge three lighted arrows which indicate to approaching vessels the direction of her course, is the subject of an experiment which may lead to the displacement of sound signals as a means of mutual warning between ships on the high seas. Of the three arrows placed conspicuously on the bridge, one is horizontal, with the point to port; another is horizontal and to starboard; while the third is pointed vertically upward. The arrows signify "I go to port," "I go to starboard," and "I continue my direction," respectively, providing visible signals not easily misunderstood.

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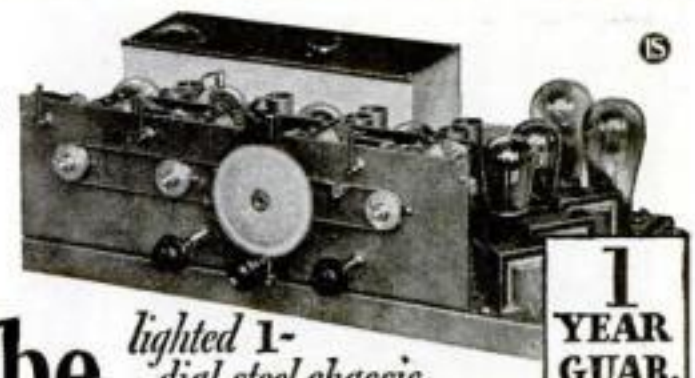

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An exquisitely new and fine, genuine walnut desk-type Mastercrest console. Very pretty and a rare bargain. Hinged top.

Spanish Treasure chest design, Mastercrest console. Finest selected grain, solid walnut. Antique wrought hardware. Marvelous value. Hinged top.

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Deal Direct with Big Factory

Miraco outfits reach you splendidly packed, rigidly tested *with everything in place ready to plug in!* No assembling! Entertain yourself 30 days—then decide. Liberal one-year guarantee on each set. Play safe, save lots of money, insure satisfaction—deal direct with Radio's old, reliable builders of fine sets—10th successful year. SEND POSTAL OR COUPON NOW for Amazing Offer!

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NAME ADDRESS

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Benjamin C. Evans, of Crawfordsville, Ind., at the metal working bench of his extraordinary home workshop. A mortgage loan broker by profession, he has made mechanics, particularly woodworking, his hobby. In the foreground is the hollow chisel mortiser and boring attachment of his variety saw; behind this is an electric drill press and supply cabinets.

For jig-sawing, Mr. Evans uses a portable machine placed on the bed of his wood-turning lathe. At the right is a 12-in. sanding disk. The larger machines are a 12-in. drum sander and a circular saw table. All the machines in the shop are motor driven, three 1-H. P., two ½ H. P., and two ¼-H. P. motors being required to operate the entire shop.

One Man Who Has Every Tool a Woodworker Needs

A general view of the shop which shows both the amazing variety of tools and the orderliness of their arrangement. All the cabinets are filled with tools and supplies. The revolving cabinet at the left holds seventy-two sizes of wood screws. In the center is a 12-in. band saw and immediately in front of it may be seen a reversible shaper, for which Mr. Evans has a large collection of cutters, an adjustable gage, and a hold down. In the background is a woodworking bench.

At the left is the jointer, in the center foreground the shaper, behind it the drum sander, and in the right background the variety saw table. Behind the jointer is a rack for bits; above is a tool cabinet, a collection of C-clamps and oilers, and a board with a number of shaper cutters and attachments. To the right along the wall is a rack for turning chisels, with cabinets above, and in the corner is the lathe and jig saw. A cabinet for paints, another for hardware and supplies, and a board for drafting instruments can be seen on the far wall.

WHAT amateur mechanic can look at Mr. Evans' workshop without a feeling of envy? Yet even if most of us cannot hope to have a shop so well equipped, we can emulate Mr. Evans in selecting only high-grade tools and machines, and in arranging them in an efficient and orderly way.

Even if your workshop is relatively small, you may have devised some special features that would interest other readers. If so, send a photograph or photographs, accompanied by a brief description, to the Home Workshop Editor. Five dollars will be paid for each print that is found sufficiently interesting for publication.

BIG AND LITTLE, RICH AND POOR, CAN PROJECT THEIR PERSONALITIES OVER THE WIDE NETWORK OF ITS WIRES

In the service of all the people

An Advertisement of the
American Telephone and Telegraph Company

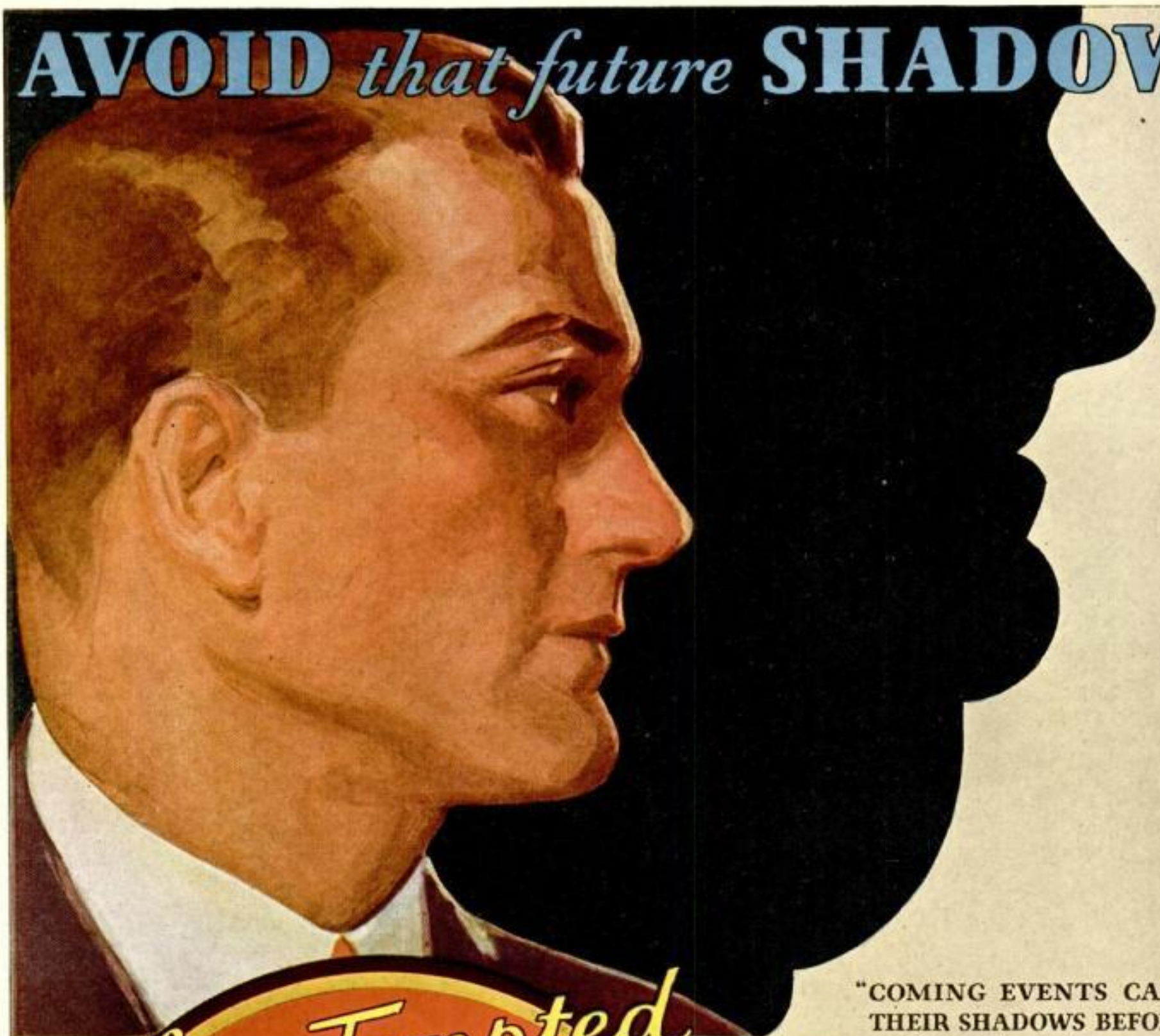
THE Bell System is owned by 450,000 stockholders and operated by more than 400,000 workers for the service of the people of the nation.

It is a democratic instrument of a democracy. Big and little, rich and poor, can project their personalities over the wide network of its wires. For friendship or business, pleasure or profit, the telephone is indispensable to our modern civilization.

This year the Bell System is erecting new telephone buildings in more than 200 cities. It is putting in thousands of miles of cable, thousands of sections of switchboard and hundreds of thousands of new telephones. Its expenditure for plant and improvements in service in 1929 will be more than 550 millions of dollars—half again as much as it cost to build the Panama Canal.

This program is part of the telephone ideal that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

AVOID *that future* SHADOW



"COMING EVENTS CAST
THEIR SHADOWS BEFORE"
[*Thomas Campbell*, 1777-1844]

When Tempted *Reach for a* LUCKY

"It's toasted" No Throat Irritation-No Cough.